

# **EVALUATION OF SYNTHETIC FUEL FOR ARMY GROUND APPLICATIONS TASKS II–VI**

**INTERIM REPORT  
TFLRF No. 389**

by  
**Edwin A. Frame  
Ruben A. Alvarez  
Douglas M. Yost**

**U.S. Army TARDEC Fuels and Lubricants Research Facility  
Southwest Research Institute® (SwRI®)  
San Antonio, Texas**

Under contract to  
**U.S. Army TARDEC  
Force Projection Technologies  
Warren, Michigan**

**Contract No. DAAE-07-99-C-L053 (WD23)  
SwRI® Project No. 03.03227.23**

**Approved for public release: distribution unlimited**

**June 29, 2007**

Report Documentation Page			Form Approved OMB No. 0704-0188		
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE <b>29 JUN 2007</b>		2. REPORT TYPE <b>Technical Report</b>		3. DATES COVERED <b>01-03-2005 to 01-06-2007</b>	
4. TITLE AND SUBTITLE <b>EVALUATION OF SYNTHETIC FUEL FOR ARMY GROUND APPLICATIONS TASKS II-IV INTERIM REPORT TFLRF NO. 389</b>			5a. CONTRACT NUMBER <b>DAAE07-99-c-L053</b>		
			5b. GRANT NUMBER		
			5c. PROGRAM ELEMENT NUMBER		
6. AUTHOR(S) <b>Edwin Frame; A. Alvarez; M. Yost</b>			5d. PROJECT NUMBER <b>SwRI 08.03227.23</b>		
			5e. TASK NUMBER		
			5f. WORK UNIT NUMBER		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>U.S. Army TARDEC Fuels and Lubricants Research Facility ,Southwest Research Institute,P.O. Drawers 28510,TX,78228-0510</b>			8. PERFORMING ORGANIZATION REPORT NUMBER <b>TFLRF No. 389</b>		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) <b>U.S. Army TARDEC, 6501 E.11 Mile Rd, Warren, MI, 48397-5000</b>			10. SPONSOR/MONITOR'S ACRONYM(S) <b>TARDEC</b>		
			11. SPONSOR/MONITOR'S REPORT NUMBER(S) <b>#22400</b>		
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release; distribution unlimited</b>					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT <b>A series of investigations were conducted to determine the effects of using synthetic fuel (S-8) in Army ground vehicles and equipment. Issues addressed included: fuel system elastomer identity and compatibility with synthetic fuel, cold starting performance of S-8 in a 6.5L diesel engine (HMMWV), and determination of S-8 and S-8/JP-8 blend fuel properties.</b>					
15. SUBJECT TERMS <b>Synthetic Fuel Fischer-Tropsch S-8 Fuel Elastomer compatibility JP-8 Cold starting Fuel properties GEP 6.5 L Engine Fuel Lubricity</b>					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT <b>Same as Report (SAR)</b>	18. NUMBER OF PAGES <b>278</b>	19a. NAME OF RESPONSIBLE PERSON
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>			

Disclaimer: Reference herein to any specific commercial company, product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or the Department of the Army (DoA). The opinions of the authors expressed herein do not necessarily state or reflect those of the United States Government or the DoA, and shall not be used for advertising or product endorsement purposes

### **Disclaimers**

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

Trade names cited in this report do not constitute an official endorsement or approval of the use of such commercial hardware or software.

### **DTIC Availability Notice**

Qualified requestors may obtain copies of this report from the Defense Technical Information Center, Attn: DTIC-OCC, 8725 John J. Kingman Road, Suite 0944, Fort Belvoir, Virginia 22060-6218.

### **Disposition Instructions**

Destroy this report when no longer needed. Do not return it to the originator.

# **EVALUATION OF SYNTHETIC FUEL FOR ARMY GROUND APPLICATIONS TASKS II–VI**

**INTERIM REPORT  
TFLRF No. 389**

by  
**Edwin A. Frame  
Ruben A. Alvarez  
Douglas M. Yost**

**U.S. Army TARDEC Fuels and Lubricants Research Facility  
Southwest Research Institute® (SwRI®)  
San Antonio, Texas**

Under contract to  
**U.S. Army TARDEC  
Force Projection Technologies  
Warren, Michigan**

**Contract No. DAAE-07-99-C-L053 (WD23)  
SwRI® Project No. 03.03227.23**

**Approved for public release: distribution unlimited**

**June 29, 2007**

**Approved by:**

**Steven D. Marty, P.E., Director  
U.S. Army TARDEC Fuels and Lubricants  
Research Facility (SwRI®)**

REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. <b>PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.</b>					
1. REPORT DATE (DD-MM-YYYY) 29-06-2007		2. REPORT TYPE Final Interim Report		3. DATES COVERED (From - To) March 2005 to June 2007	
4. TITLE AND SUBTITLE Evaluation of Synthetic Fuel for Army Ground Applications: Tasks II-VI				5a. CONTRACT NUMBER DAAE07-99-C-L053	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) E.A. Frame, R.A. Alvarez, and D.M. Yost				5d. PROJECT NUMBER SwRI 08.03227.23	
				5e. TASK NUMBER WD 23	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)  U.S. Army TARDEC Fuels and Lubricants Research Facility (SwRI®) Southwest Research Institute® P.O. Drawer 28510 San Antonio, TX 78228-0510				8. PERFORMING ORGANIZATION REPORT NUMBER TFLRF No. 389	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)  U.S. Army RDECOM U.S. Army TARDEC Force Projection Technologies Warren, MI 48397-5000				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT  A series of investigations were conducted to determine the effects of using synthetic fuel (S-8) in Army ground vehicles and equipment. Issues addressed included: fuel system elastomer identity and compatibility with synthetic fuel, cold starting performance of S-8 in a 6.5L diesel engine (HMMWV), and determination of S-8 and S-8/JP-8 blend fuel properties.					
15. SUBJECT TERMS  <div style="display: flex; justify-content: space-between;"> <span>Synthetic Fuel</span> <span>Fischer-Tropsch</span> <span>S-8 Fuel</span> <span>Elastomer compatibility</span> </div> <div style="display: flex; justify-content: space-between;"> <span>JP-8</span> <span>Cold starting</span> <span>Fuel properties</span> <span>GEP 6.5 L Engine</span> <span>Fuel Lubricity</span> </div>					
16. SECURITY CLASSIFICATION OF:				17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES
19a. NAME OF RESPONSIBLE PERSON					
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified	Unclassified	271	19b. TELEPHONE NUMBER (include area code)

## EXECUTIVE SUMMARY

As the military moves forward to explore alternative fuel sources to reduce the dependency in petroleum fuel, non-conventionally produced fuels increase in viability. The synthetic fuel (S-8) used in these evaluations is one such type fuel produced from a synthesis process developed early in the last century known as Fischer-Tropsch. Evaluation results provided in this report play an important role in the ability of synthetic fuel to someday significantly increase energy security and enable U.S. military ground equipment to operate using an alternative hydrocarbon fuel.

Elastomer compatibility tests were conducted. As a result of elastomer compatibility and fuel switch load tests, it was determined that elastomers made out of Viton rubber exhibited the least amount of mass and volume gains and losses. Butadiene rubber elastomers exhibited insignificant mass changes and approximately two percent volume variations from starting values when switched between fuels. Fluorosilicone elastomers exhibited intermediate mass and volume changes. The elastomers containing Nitrile rubber showed the largest volume loss of the seals evaluated.

Cold starting evaluations were conducted. Based on the limitations of test hardware for attaining absolute start temperature thresholds, the following cold starting conclusions can be made for the S-8, S-8/JP-8, and JP-8 fuels in the General Engine Products 6.5L, naturally-aspirated, IDI, diesel engine:

- With a constant speed cranking motor at 100-RPM and glow plugs utilization the data suggest the cetane number difference between fuels is not evident in the start times.
- There is a slight improvement in engine warm up time with S-8 content in the fuel blends. The decrease in warm up time is small compared to the overall time to warm up the engine.
- The Exhaust Opacity data at -25°C suggests there is a similar amount of white smoke for each test fuel, however at -20°C both the average and maximum exhaust opacity due to white smoke are reduced with S-8 fuel content.
- The largest variation between test fuels is seen for the Unburned Hydrocarbons (UHC) in the exhaust. Both the average and maximum UHC are lower with increasing S-8 content in the fuel. When cold starting aids are utilized, it is apparent there is less UHC in the exhaust at cold temperatures with increasing S-8 content.

- Start times when the engine is cranked with a battery and starter, and the glow plugs disabled; indicate the engine will start on S-8 at 3°C. The engine would not start on JP-8 at 3°C without glow plugs. The engine did start with the S-8/JP-8 blend after a sixth crank attempt at 3°C.
- During cold starting without glow plugs there are substantial maximum levels of white smoke, regardless of fuel type. However, the S-8 fuel has a reduced average exhaust opacity due to the engine eventually starting at 3°C without the use of glow plugs.
- When cold starting without glow plugs there are substantial maximum levels of unburned hydrocarbons, regardless of fuel type. Corresponding to the exhaust opacity result, the S-8 fuel also has reduced average unburned hydrocarbons due to the engine starting at 3°C without the use of glow plugs.
- Overall, S-8 provided better low temperature starting than JP-8 in the 6.5L engine.

A survey of elastomer types used in Army diesel injection pumps was conducted. The most prominent rubber material found in the survey of injection pump elastomers was Viton. Viton is a synthetic rubber and fluoropolymer elastomer commonly used in O-rings. Based on previous testing, Viton elastomers should present minimal problems if any, with the introduction of synthetic fuels.

- Elastomeric components found in injection pumps of selected high-density combat, wheeled and ground support equipment, were identified.
- An injection pump elastomer identification table was developed.
- An estimation was made on the potential for injection pump leakage based on composition of elastomers and their location within the pump, and whether leakage, if it occurred, would be external or internal.
- Of the pumps identified, the model PSB 12BT pump fueling the AVDS 1790 engines in the recovery vehicle, engineer vehicle and the AVLB bridge launcher is the pump that raises the most concern with the use of non-aromatic fuel (S-8). The reason being that there are two head assembly static seals in each hydraulic head and two fuel control dynamic seals made

out of butadiene and Arylonitrile material. These seals are dual-purpose seals that prevent lubricating oil and fuel from commingling within the pump. The fact that the material is a combination of butadiene and Arylonitrile may lessen the effect of shrinkage as opposed to pure Nitrile material.

Fuel properties were determined for a 50/50% vol. Blend of S-8 and JP-8 petroleum based aviation fuel. The blend was analyzed according to the testing protocols listed in DEF STAN 91-91 Table 1.

The data were examined for compliance with JP-8 and DEF STAN 91-91 specifications. The following results for S-8 containing fuel were outside of the specification limits:

- The standard BOCLE result for S-8 was high
- The density for S-8 and the blend was low
- D86 residue and loss were slightly high for the blend



## **FOREWORD/ACKNOWLEDGMENTS**

The U.S. Army TARDEC Fuels and Lubricants Research Facility (TFLRF) located at Southwest Research Institute (SwRI<sup>®</sup>), San Antonio, Texas, performed this work during March 2005 through June 2007 under Contract No. DAAE-07-99-C-L053. The U.S. Army Tank-Automotive RD&E Center, Force Projection Technologies, Warren, Michigan, administered the project. Mr. Luis Villahermosa (AMSTA-RBFF) served as the TARDEC contracting officer's representative. Ms. Pat Muzzell and Mr. Eric Sattler of the Fuel Cell Technology Team, National Automotive Center, U.S. Army RDECOM-TARDEC served as the project technical monitors.

The authors would like to acknowledge the contribution of Ms. Marilyn Voight and the TFLRF technical support staff, along with the administrative and report-processing support provided by Ms. Rebecca Emmot.

## TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
I. Introduction and Background .....	1
II. Task II .....	1
A. Bench Scale Lubricity Testing of USAF Additives.....	1
B. Impact on Field Elastomers when Switch-Loaded between Synthetic and Petroleum Fuels	2
1.0 Objective .....	2
2.0 Approach.....	3
2.1 Field Elastomers.....	3
2.2 Elastomers Selected for Testing.....	5
2.3 Fuels Utilized For Elastomer Switch Loading.....	6
2.4 Test Procedure .....	6
3.0 Results and Discussion .....	7
3.1 Stanadyne Pump.....	8
3.2 Bosch In-Line Pump .....	13
3.3 Detroit Diesel Unit Injector .....	18
4.0 Conclusions and Recommendations .....	20
5.0 References for Task II.....	22
III. Task III: Cold Starting Performance of JP-8: Fischer-Tropsch Derived versus Petroleum Derived.....	23
1.0 Background.....	23
2.0 Objective .....	23
3.0 Discussion .....	24
4.0 Approach.....	25
5.0 Experimental Results .....	26
6.0 Discussion of Results.....	43
7.0 Summary and Conclusions .....	56
8.0 References for Task III .....	58
IV. Task IV: Identification of Army Fuel Injection Pump Elastomers .....	58
1.0 Objectives .....	58
2.0. Approach.....	59
3.0 Discussion.....	60
4.0 Summary and Conclusion .....	65
5.0 Recommendations.....	66
V. Task V: JP-8/S-8 Fuel Blend Study .....	66
1.0 Approach.....	66
2.0 Results.....	67
VI. Task VI: BOCLE Data for Reference Fluids.....	72
1.0 Approach.....	72
2.0 Results.....	72
Appendices.....	73

## LIST OF TABLES

<u>Table</u>	<u>Page</u>
Table II-1. Lubricity Bench Test Results.....	2
Table II-2. Summary of Elastomer Type in High Density US Army Fuel Systems.....	3
Table II-3. Fuels Utilized for Switch Loading Tests .....	6
Table II-4. Averaged Total Changes in Elastomer Mass and Volume % Weight When Switch-Loaded Between Non- Aromatic and Aromatic Fuels.....	22
Table III-1. S-8 Test Fuel Cold Start Performance in 6.5L Engine .....	44
Table III-2. JP-8 Test Fuel Cold Start Performance in 6.5L Engine .....	45
Table III-3. 50%S-8 / 50% JP-8 Test Fuel Cold Start Performance in 6.5L Engine .....	46
Table IV-1. High Density and or Mission Critical Equipment.....	59
Table IV-2. Elastomer Materials Identified in ID Table.....	61
Table IV-3. Elastomer Materials Identified in ID Table Grouped by Family .....	62
Table V-1. Fuel Blend Property Results .....	68
Table V-2. Lubricity Results with AL-26955A (Ondeo/Nalco Additive) CI/LE.....	71

## LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
Figure II-1. Stanadyne Injection Pump Calculated by Method A from Days 0-7, 0-28, 0-35, 0-56, 0-63, 0-84, 0-91, 91-112 to Obtain Cumulative Mass % changes in Viton Elastomers in all Fuels .....	8
Figure II-2. Stanadyne Injection Pump Calculated by Method A from Days 0-7, 0-28, 0-35, 0-56, 0-63, 0-84, 0-91, 91-112 to Obtain Cumulative Volume % changes in Viton Elastomers in all Fuels .....	9
Figure II-3. Stanadyne Injection Pump Calculated by Method A from Days 0-7, 0-28, 0-35, 0-56, 0-63, 0-84, 0-91, 91-112 to Obtain Cumulative Mass % changes in Fluorosilicone Elastomers in all Fuels .....	10
Figure II-4. Stanadyne Injection Pump Calculated by Method A from Days 0-7, 0-28, 0-35, 0-56, 0-63, 0-84, 0-91, 91-112 to Obtain Cumulative Volume % changes in Fluorosilicone Elastomers in all Fuels .....	11
Figure II-5. Fluorosilicone Drive Shaft Seals .....	11
Figure II-6. Stanadyne Injection Pump Calculated by Method A from Days 0-7, 0-28, 0-35, 0-56, 0-63, 0-84, 0-91, 0-112 to Obtain Cumulative Mass % changes in Fluorosilicone Elastomers in Fuels. Aberrant Red Shaft Seal Removed from Calculated Average .....	12
Figure II-7. Stanadyne Injection Pump Calculated by Method A from Day 0-7, 0-28, 0-35, 0-56, 0-63, 0-84, 0-91, 0-112 to Obtain Cumulative Volume % changes in Fluorosilicone Elastomers in all Fuels. Aberrant Red Shaft Seal Removed from Calculated Average .....	13
Figure II-8. Nitrile Encapsulated Steel Fuel Gallery Seal/Washer Used in the Bosch Pump .....	14
Figure II-9. Bosch In-Line Injection Pump Calculated by Method A from Day 0-7, 0-28, 0-35, 0-56, 0-63, 0-84, 0-91, 0-112 to Obtain Cumulative Mass % changes in Butadiene Elastomers in all Fuels .....	15
Figure II-10. Bosch In-Line Injection Pump Calculated by Method A from day 0-7, 0-28, 0-35, 0-56, 0-63, 0-84, 0-91, 0-112 to Obtain Cumulative Volume % changes in Butadiene Elastomers in all Fuels .....	16

Figure II-11. Bosch In-Line Injection Pump Calculated by Method A from Day 0-7, 0-28, 0-35, 0-56, 0-63, 0-84, 0-91, 0-112 to Obtain Cumulative Mass % changes in Nitrile Elastomers in all Fuels.....	17
Figure II-12. Bosch In-Line Injection Pump Calculated by Method A from Day 0-7, 0-28, 0-35, 0-56, 0-63, 0-84, 0-91, 0-112 to Obtain Cumulative Volume % changes in Nitrile Elastomers in all Fuels.....	18
Figure II-13. Detroit Diesel Injection Pump Calculated by Method A from Day 0-7, 0-28, 0-35, 0-56, 0-63, 0-84, 0-91, 0-112 to Obtain Cumulative Mass % changes in Viton Elastomers in all Fuels.....	19
Figure II-14. Detroit Diesel Injection Pump Calculated by Method A from Day 0-7, 0-28, 0-35, 0-56, 0-63, 0-84, 0-91, 0-112 to Obtain Cumulative Volume % changes in Viton Elastomers in all Fuels.....	20
Figure III-1. Engine and Cranking Speeds with JP-8 at -28°C.....	27
Figure III-2. Fuel and Oil Pressures with JP-8 at -28°C.....	28
Figure III-3. Temperatures during Start and Warm-Up Period with JP-8 at -28°C.....	28
Figure III-4. Starting with Glow Plugs Activated with JP-8 at -25°C.....	30
Figure III-5. Exhaust Opacity and Unburned Hydrocarbons with JP-8 at -25°C.....	31
Figure III-6. Plots of Temperatures and Oil Pressure with JP-8 at -25°C.....	32
Figure III-7. Glow Plug Effects on Cold Start with JP-8 at -25°C.....	35
Figure III-8. Temperature Histories during Cranking without Glow Plugs with JP-8 at -25°C..	36
Figure III-9. JP-8 Fuel Cold Start Exhaust Parameters.....	37
Figure III-10. S-8 Cold Start Exhaust Parameters.....	37
Figure III-11. Engine Speed for JP-8 and S-8 Cold Start Attempts at -25°C.....	38
Figure III-12. JP-8 and S-8 Cold Start Temperature Profiles at -25°C.....	39
Figure III-13. Oil Gallery Pressure and Sump Temperature for JP-8 and S-8 Start Attempts ....	40
Figure III-14. Exhaust Opacity for JP-8 and S-8 Start Attempts.....	41
Figure III-15. Unburned Hydrocarbons from JP-8 and S-8 Cold Start Attempts.....	41
Figure III-16. Start Time at -25°C with Starting Aids and Cranking Motor.....	47
Figure III-17. Warm Up Time at -25°C with Starting Aids and Cranking Motor.....	48
Figure III-18. Exhaust Opacity at -25°C with Starting Aids and Cranking Motor.....	48
Figure III-19. Exhaust Unburned Hydrocarbons at -25°C with Starting Aids and Cranking Motor.....	49
Figure III-20. Start Time at -20°C with Starting Aids and Cranking Motor.....	50
Figure III-21. Warm Up Time at -20°C with Starting Aids and Cranking Motor.....	50
Figure III-22. Exhaust Opacity at -20°C with Starting Aids and Cranking Motor.....	51
Figure III-23. Exhaust Unburned Hydrocarbons at -20°C with Starting Aids and Cranking Motor.....	51
Figure III-24. Start Time at 3°C without Starting Aids and with Battery/Starter.....	52
Figure III-25. Warm Up Time at 3°C without Starting Aids and with Battery/Starter.....	53
Figure III-26. Exhaust Opacity at 3°C without Starting Aids and with Battery/Starter.....	53
Figure III-27. Exhaust Unburned Hydrocarbons at 3°C without Starting Aids and with Battery/Starter.....	54
Figure III-28. Exhaust Opacity at 6°C without Starting Aids and with Battery/Starter.....	55
Figure III-29. Exhaust Unburned Hydrocarbons at 6°C without Starting Aids and with Battery/Starter.....	56

## ACRONYMS AND ABBREVIATIONS

%	Percent
Δ	Delta
°C	Degrees centigrade
°F	Degrees Fahrenheit
@	at
AO	Antioxidant
ASTM	American Society for Testing and Materials
bhp	Brake horsepower
BTU/lb	British Thermal Units/pound
C.L.	Confidence limits
CAT	Caterpillar
CI/LI	Corrosion Inhibitor and Lubricity Improver
COV	Coefficient of variance
CRC	Coordinating Research Council
cSt	Centistokes
DDC	Detroit Diesel Corporation
DOD	Department of Defense
FBP	Final boiling point
FSII	Fuel System Icing Inhibitor
FT	Fischer-Tropsch
FTM	Federal Test Method
GTL	Gas-to-liquid
HEMTT	Heavy Expanded Mobility Tactical Truck
HEUI	Hydraulically Actuated Electronic Unit Injector
HFRR	High-frequency reciprocating rig
HMMWV	High Mobility Multipurpose Vehicle
Hr	Hour
IBP	Initial boiling point
IDI	Indirect injection
IQT	Ignition Quality Tester
JFTOT	Jet Fuel Thermal Oxidation Tester
L	Liter
max	Maximum
MDA	Metal deactivator additive
mg	Milligram
mg/L	Milligrams per liter
mgKOH/g	Milligrams potassium hydroxide per gram of sample
MJ/kg	Megajoules per kilogram
ml	Milliliter
mm	Millimeter
mmHG	Millimeters of mercury
mpg	Miles per gallon
MSEP	Micro-Separometer
NR	Not required
oz	Ounce

**ACRONYMS AND ABBREVIATIONS (continued)**

Pa	Pascuals
PN	Part number
ppm	Parts per million
pS/m	pico Siemens per meter
psig	Pounds per square inch, gauge
RPM	Revolutions per minute
SLBOCLE	Scuffing load ball on cylinder lubricity evaluator
STDEV	Standard deviation
SwRI <sup>®</sup>	Southwest Research Institute <sup>®</sup>
TFLRF	U.S. Army TARDEC Fuels and Lubricants Research Facility
UHC	Unburned Hydrocarbons
WPAFB	Wright Patterson Air Force Base

## **I. INTRODUCTION AND BACKGROUND**

Fischer-Tropsch (FT) process synthetic fuels, first produced in 1927, were used by WWII Germany and by South Africa during their embargoed period, to overcome petroleum shortages. Synthetic JP-8 is a clean fuel that contains no sulfur or aromatics, but has historically cost too much to compete with petroleum fuel. Since the mid-1990s, the world's major energy companies have begun developing updated FT processes that are cheaper to build and operate. The goal is to produce a sulfur-free product that helps meet air quality requirements, and to consume natural gas that can no longer be flared due to environmental rules. However, synthetic fuel chemistry differs significantly from petroleum fuels since FT synthetic fuels are free of aromatic and sulfur compounds. These differences raise many concerns, in particular with respect to: (1) adequate lubrication of some engine fuel systems and other equipment, and (2) maintaining enough seal swell to avoid leakage when fuel systems are switched between petroleum and synthetic fuels. The results of several research tasks that were conducted to investigate the potential use of synthetic fuel in Army ground equipment are included in this report.

## **II. TASK II**

### **A. BENCH SCALE LUBRICITY TESTING OF USAF ADDITIVES**

Because synthetic fuel has poor lubricity properties, lubricity enhancer additives are desirable. Five experimental lubricity enhancer additives were received from WPAFB and were evaluated for effectiveness in the latest batch of synthetic fuel designated S-8 (AL-27074-F). Based on USAF-reported BOCLE results, the additives were blended at 25-mg/L concentration and evaluated in the HFRR (D6079) and SLBOCLE (D6078). The bench test lubricity results are shown in Table II-1.

<b>Table II-1. Lubricity Bench Test Results</b>				
<b>Fuel ID</b>	<b>Additive</b>	<b>Description</b>	<b>HFRR, microns</b>	<b>SLBOCLE, g</b>
Neat S-8	None		795	1050
04-865	03-POSF-4525	Unpurified phthalic acid monoester	760	1450
04-866	02-POSF-4147	Alkoxyl proponic acid	710	2100
04-867	02-POSF-4145	Alcohol glyceryl ester	740	1650
04-868	02-POSF-4146	Alcohol succinic mono ester	780	1650
04-869	03-POSF-4524	C16-C17 branched alcohol phthalic monoester	750	1550
All additives tested at 25 mg/l in neat S-8, AL-27074				
HFRR, D6079 repeatability is 80 microns				
SLBOCLE D6078 repeatability is 900 g				

Overall, the bench tests indicated directional improvement in fuel lubricity with each additive present. Additive 02-POSF-4147 produced improvement in the SLBOCLE test and the HFRR test that was beyond test repeatability. It is recommended that this additive be tested at slightly higher concentration levels, and its impact on other fuel properties should be determined.

## **B. IMPACT ON FIELD ELASTOMERS WHEN SWITCH-LOADED BETWEEN SYNTHETIC AND PETROLEUM FUELS**

### **1.0 OBJECTIVE**

The objective of this study was to determine the acceptability of synthetic fuel for use in Army ground vehicles and equipment. The response of selected new and used elastomers was determined when seals were switched between petroleum and synthetic fuel. Previous fuel system material compatibility and switch-load testing was conducted by TARDEC and other organizations [1–7]. The injection system elastomers selected for this study are the actual elastomeric parts (both new and used) found in the high-density Army ground equipment, such as the HMMWV, HEMTT, and M939A2 series wheeled vehicles. Ultimately, the ability of the O-rings/seals of selected fuel injection systems to maintain enough swell to avoid leakage will determine the proof of concept in the use of synthetic fuel.



## 2.0 APPROACH

### 2.1 Field Elastomers

Three primary types of fuel injection equipment were investigated. They include a Stanadyne rotary pump (HMMWV), a Bosch inline pump from the Cummins 6CTA 8.3 engine (older model 2.5-5T cargo trucks), and a unit injector from the DDC 8V92T engine (HEMTT). A listing of the elastomer materials in each system is presented in Table II-2. Because the Detroit Diesel UI contains only one elastomer, a fourth injection system was going to be added to the investigation. This is the Caterpillar 3116 and 3126B engine hydraulically actuated electronic unit injector (HEUI). The light and medium family of tactical vehicle (trucks) use the HEUI system. However, the fuel-wetted elastomers in the HEUI system are made of Viton and very similar in function as the Detroit Diesel elastomers; therefore, it was decided not to include it in the test matrix

<b>Table II-2. Summary of Elastomer Type in High Density US Army Fuel Systems</b>		
<b>Stanadyne DB2 Rotary Injection Pump used in the GM 6.2L and 6.5L</b>		
<u>p/n</u>	<u>Description</u>	<u>Elastomer type</u>
10453	Seal, (driveshaft)	Fluorocarbon (Viton)
21860	Seal, (driveshaft red)	Fluorosilicone (Red)
27603	Gasket, (timing window cover)	Fluorocarbon (Viton)
27245	Seal, O-ring (cam ring/hyd head)	Fluorocarbon (Viton)
27601	Seal, O-ring	Fluorocarbon (Viton)
27608	Seal, (transfer pump)	Fluorocarbon (Viton)
11507	Seal, O-ring (gov. assembly)	Fluorocarbon (Viton)
24585	Seal, O-ring (shaft control assy)	Fluorocarbon (Viton GLT)
27609	Seal, O-ring (drain plug)	Fluorocarbon (Viton)
27610	Seal, O-ring	Fluorocarbon (Viton)
27163	Seal, (advance plunger)	Seal (Viton) / Case AISI C1008-C1010
27602	Seal, O-ring	Fluorocarbon (Viton)
27607	Seal, O-ring	Fluorocarbon (Viton)
27244	Seal, rect section	Fluorocarbon (Viton)
<b>Bosch In-Line Injection Pump Used in the Cummins 6CTA 8.3 engine</b>		
<u>p/n</u>	<u>Description</u>	<u>Elastomer type</u>
1410210014	Seal, O-ring (barrel assembly)	Butadiene
2410210049	Seal, O-ring (barrel assembly)	Butadiene
2410210033	Delivery valve holder, seal O-ring	Butadiene
3918192	Fuel gallery, seal washer	BUNA N (Nitrile)

<b>Table II-2. (continued)</b>		
<b>Stanadyne DB2 Rotary Injection Pump used in the GM 6.2L and 6.5L</b>		
<b>DD Unit Self- Metering Injector used in the Detroit Diesel 8V92T engine</b>		
<u><i>p/n</i></u>	<u><i>Description</i></u>	<u><i>Elastomer type</i></u>
52344281	Seal, O ring	Fluorocarbon (Viton)
<b>Hydraulically Actuated Electronic Unit Injector (HEUI) used in Caterpillar 3116 and 3126B engine</b>		
<u><i>p/n</i></u>	<u><i>Description</i></u>	<u><i>Elastomer Type</i></u>
1P8116	Seal, O ring	Fluorocarbon (Viton)
125-8274	Seal, O ring	Fluorocarbon (Viton)

A source of used elastomers for the Stanadyne rotary injection pump and the DDC unit injector was located at Ft. Hood, Texas. This rebuild facility was visited, and used elastomers were obtained from three Stanadyne rotary injection pumps and three DDC unit injectors.

Ft. Carson, Colorado, is the designated depot repair facility for the complete overhaul of the Bosch in-line injection pump for the Cummins 8.3L engine. Personnel at the Component Repair Facility were contacted concerning obtaining used elastomers from three in-line pumps. However, the shop supervisor informed TFLRF staff that the injection pump overhauls have been temporarily suspended due to a high priority work directive to up-armor HMMWV model vehicles. New injection pumps are being issued and installed when necessary. Tentative plans were made with the Ft. Carson repair facility to have the repair shop ship three used injection pumps to TFLRF. The used elastomers would be removed and the pumps rebuilt and returned to Ft. Carson. In order to accomplish the rebuild procedure, special tools were required to be purchased, a technician had to be trained at one of the local diesel injection pump facilities, and finally the injection pump had to be calibrated prior to shipment to Ft. Carson. Pursuing this course of action became cost prohibitive and searching for a local source of used elastomers for Cummins 6CTA8.3 engine became the only viable course of action.

Local Cummins engine dealers and diesel injection repair facilities provided the necessary used Bosch in-line pump elastomers.

New elastomer overhaul kits were purchased for the Stanadyne rotary injection pump, Bosch in-line injection pump and Detroit Diesel unit injectors.

## 2.2 Elastomers Selected for Testing

The following elastomers were selected for testing:

A. Stanadyne Injection Pump	Elastomer Composition
Head & Rotor Assembly	Viton
Transfer Pump O-ring	Viton
Shaft seal (red)	Fluorosilicone
Shaft seal (black)	Viton
Gov. Assembly Stud Guide O-ring	Viton* (see Stanadyne paragraph below)
B. Bosch In-Line Injection Pump	
Delivery Valve O-ring	Butadiene
Barrel Assembly O-ring (black)	Butadiene
Barrel Assembly O-ring (green)	Butadiene
Fuel Gallery seal/washer	Nitrile
C. Detroit Diesel Unit Injector	
Injector O-ring	Viton

The elastomer sets for each component consisted of two new and three used O-rings/seals. One set of the new O-rings/seals were suspended in air and were subjected to the weighing and oven process as all the other O-rings/seals; however, they were not submerged in fuel at any time. It was felt that these sets of new seals would provide a good control weight that would give a better perspective to the weights obtained from the other sets of new and used seals that would be submerged in non-aromatic and aromatic fuels. For the most part, the mass and volume weight percent gains and losses remained within expected parameters except in two instances where the volume weight percent loss cannot be explained other than perhaps an error in recording the weight. The remaining sets of new and used O-rings/seals were submerged in the different fuels at all times except when being prepared for weighing and switch loading.

For the Stanadyne pump, the Governor Assembly Stud Guide O-rings were ordered from a local diesel injection business using a part number obtained from the list of elastomer numbers provided to TFLRF by TACOM and reported to be made of Nitrile material. According to the local dealer, the part number used to order the O-ring had been superseded by another part

number and the material of the O-ring is now Viton. TFLRF staff contacted the Product Support Department at the Stanadyne Corporation in an attempt to settle concerns regarding O-ring composition & color. Specifically to confirm that the gasket set PN24370 contains one PN11507 black Nitrile O-ring for the guide stud and another O-ring that is the same size for the head locating screw PN27602 made out of Viton and red in color. The local dealer stated that PN11507 Nitrile O-ring had been superseded by PN27602. TFLRF asked the support specialist whether the supersession originated from Stanadyne or if it could be a dealer implemented procedure. The answer that Stanadyne provided was that “Gasket Kit PN 24370 contains 11507 and 27602 O-ring seals. Both O-rings are “good” part numbers in the Stanadyne system and neither is pending supersession. The 11507 seals are Black in color and made from Nitrile and the 27602 seals are Red and made from Viton. The 27602 seals may also have an optional fluorescent whitening agent in color coating. We checked the O-rings that we had tested thinking that the composition was Nitrile and all turned out to be red in color and therefore Viton instead of Nitrile.

### 2.3 Fuels Utilized For Elastomer Switch Loading

The three fuels that were used for this study are S-8 [1] Synthetic Fuel, a fuel produced by Syntroleum Corporation using their gas-to-liquids technology to convert natural gas into liquid hydrocarbon fuel. The other fuel used was Aviation Turbine Fuel designated as JP-8. [2] A blend of S-8 fuel and 15% volume aromatic additive designated as +150 [3] was used as an additional fuel for the elastomer switch loading. Table II-3 shows the list of fuels used:

<b>Table II-3. Fuels Utilized for Switch Loading Tests</b>		
<b>Fuel Name</b>	<b>Description</b>	<b>Sample No.</b>
S-8	0% aromatic content	AL-27074-F
JP-8	Approx. 15% wt aromatic content	AL-26936-F
S-8+150	15% wt aromatic content	CL05-0152

### 2.4 Test Procedure

The new and used elastomers were weighed suspended in air and then weighed submerged in water in accordance with ASTM 471 procedures with some modifications [2]. Weights were recorded for the commencement of the test. The elastomers were then placed in glass containers filled with S-8 non-aromatic fuels and stored at 40°C (104°F) for seven days. At the end of the

7-day period in the S-8 fuel, the elastomers were again weighed in air and water, measurements recorded. The elastomers were again submerged in the same non-aromatic fuel for an additional 21 days. At the end of the 28 day period, the elastomers were removed from the S-8 fuel, rinsed, allowed to dry to room temperature and measurement procedures repeated. The elastomers were then submerged in JP-8 fuel for 28 days and then submerged in JP-8+150 for 28 days. This process was repeated for four complete 28-day switch-loading cycles. Mass and volume changes were determined each time the elastomers were weighed in air and water.

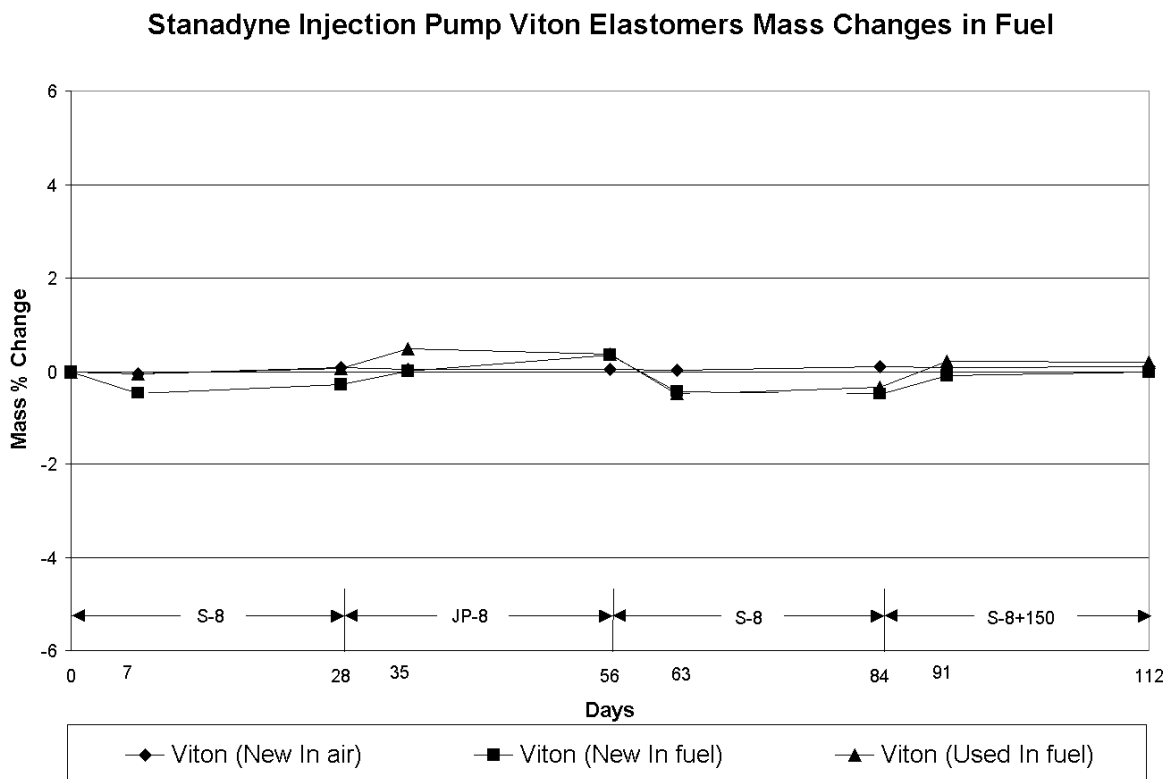
### **3.0 RESULTS AND DISCUSSION**

The results in mass and volume percent changes are presented by the different fuel injection systems investigated. First the Stanadyne Rotary Injection pump with 5 selected fuel wetted elastomers (three O-rings and two shaft seals) will be discussed, then the Bosch In-line injection pump with 4 fuel wetted elastomers (three O-rings and one washer) will follow, and finally, the Detroit Diesel unit injector with one selected elastomer (O-ring).

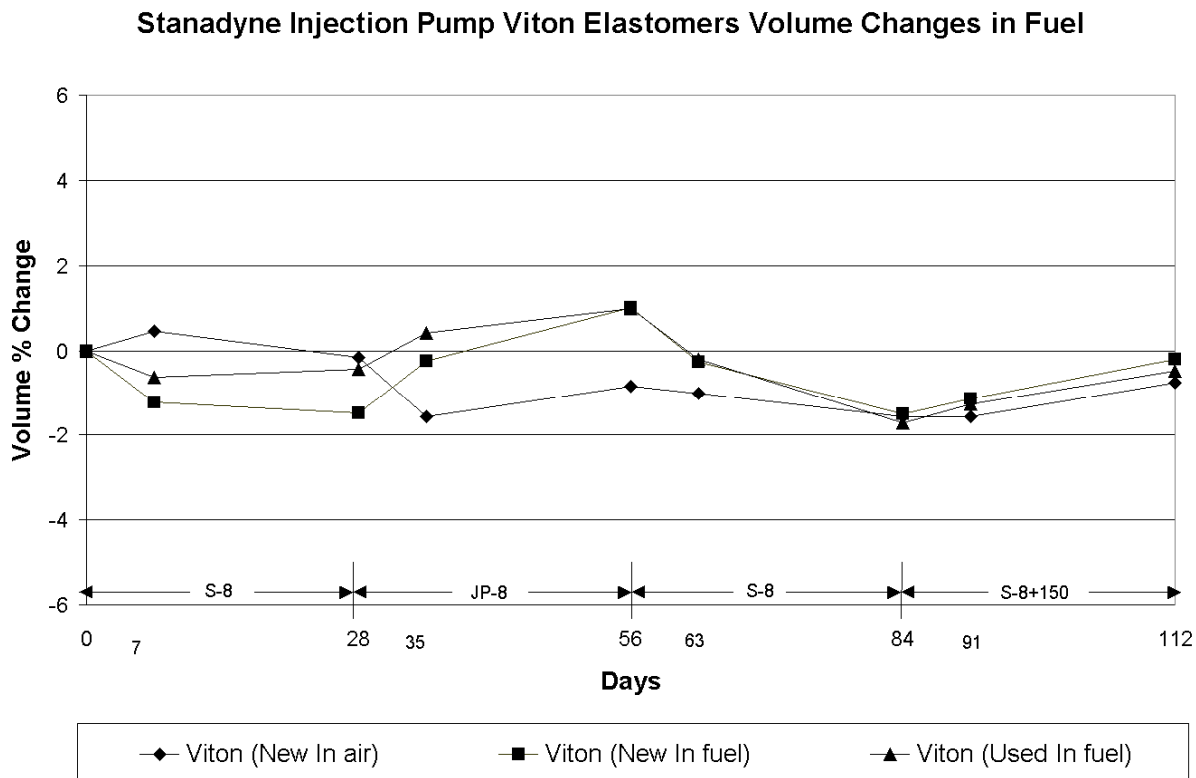
The data shown in the following charts represents the averaged total results of the same elastomer material for each pump. The data were calculated from day 0-7, 0-28, 0-35, 0-56, 0-63, 0-84, 0-91, 0-112 to obtain cumulative mass and volume percent changes in all fuels. These calculations are labeled Method A. The data were also calculated from day 0-7, 0-28, 28-35, 28-56, 56-63, 56-84, 84-91, 91-112 to obtain mass and volume percent changes in each fuel. These calculations are labeled Method B and are presented in Appendix II-A, "Grouped Elastomer Data, by Elastomer Type for Each Pump, Change Calculated by Method B." Results for individual seals are presented in Appendices II-B, II-C, and II-D. Appendix II-B presents individual elastomer results for Stanadyne pump, calculated by Method A. Appendix II-C shows the data for individual elastomers found in the Bosch In-line pump, calculated by Method A, and Appendix II-D presents the data for individual elastomers found in the Detroit Diesel unit injector, calculated by Method A.

### 3.1 Stanadyne Pump

Figures II-1 and II-2 present the mass and volume percent changes observed by method A for Viton O-rings/seals found in four different locations in the Stanadyne pump. Figure II-1 shows that the new and used elastomers exhibited slight 0.4% losses and gains in mass percent when submerged in non-aromatic and then switched to aromatic fuels. Figure II-2 shows how new and used elastomers paralleled mass percent swings closely, but were more pronounced when calculated for volume. The new elastomers exhibited greater volume losses and gains in the first two switch cycles. However, none fluctuated more than 1.7 percent. The new elastomer that was stored in air only (not submerged in fuel) remained constant in mass weight and varied slightly in volume.



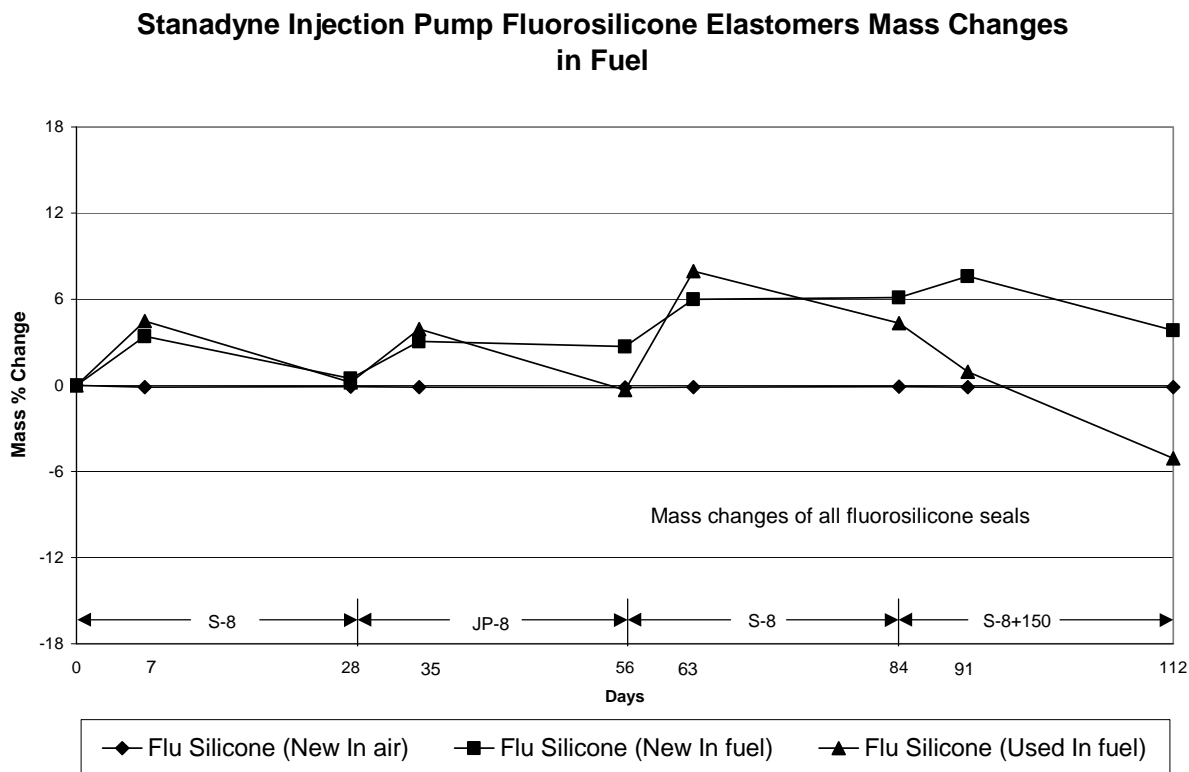
**Figure II-1. Stanadyne Injection Pump Calculated by Method A from Days 0-7, 0-28, 0-35, 0-56, 0-63, 0-84, 0-91, 91-112 to Obtain Cumulative Mass % changes in Viton Elastomers in all Fuels**



**Figure II-2. Stanadyne Injection Pump Calculated by Method A from Days 0-7, 0-28, 0-35, 0-56, 0-63, 0-84, 0-91, 91-112 to Obtain Cumulative Volume % changes in Viton Elastomers in all Fuels**

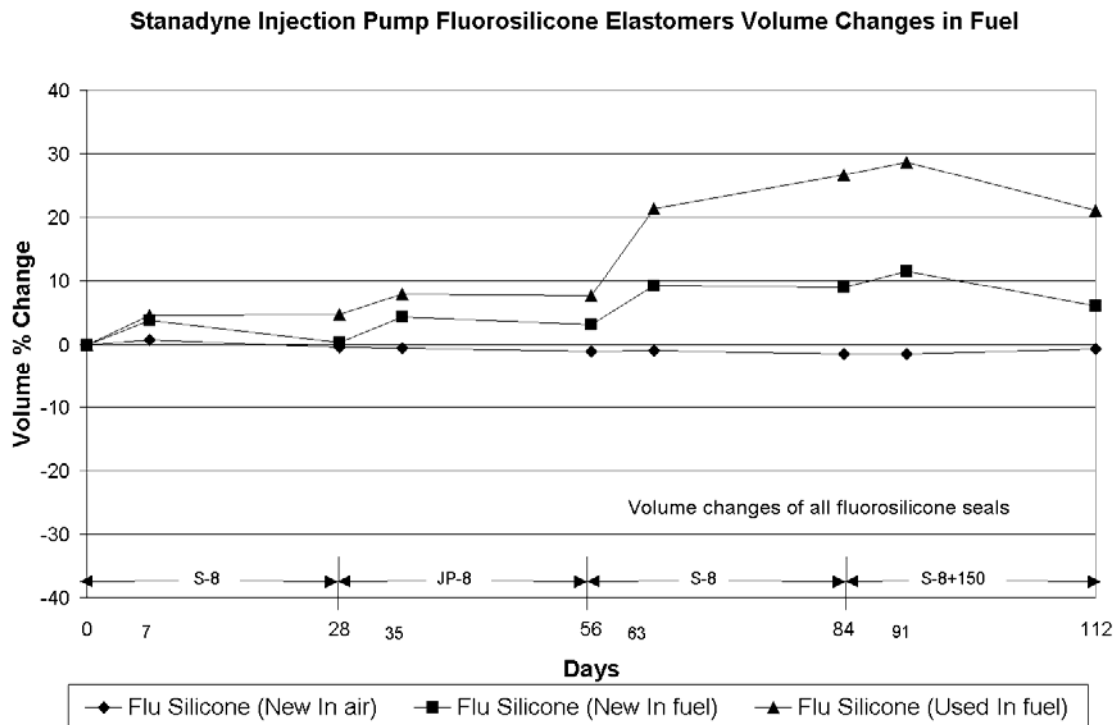
Figures II-3 and II-4 present the changes observed in the Fluorosilicone shaft seals. The new and used seals initially exhibited a sharp increase in mass and volume percent at the end of seven days in non-aromatic fuel; however, by the end of the 28<sup>th</sup> day, the mass and volume had decreased to near initial starting values. Mass and volume percent increased sharply after every seven-day submersion in non-aromatic or aromatic fuel. The increases however, are greater after switching to non-aromatic fuel. Mass and volume would then decrease to starting values during the next 21-day submersion. This pattern continued throughout the fuel switches until the last switch to non-aromatic fuel additized with 15% aromatics. The used seals exhibited an approximately 10% decrease in mass weight from day 84 to 112. The increase is more significant in the used seals due to the behavior of the seal in pump No. 1. From the beginning, the used seal labeled P 1-3 from pump No 1 behaved erratically and very different than the other two. The observed mass and volume increased at an unusually high rate when submerged in either fuel; however, the swelling was more pronounced with non-aromatic fuel. The texture of the seal

became spongy and highly swollen. Figure II-5 shows the swollen condition of the used seal P 1-3 after being submersed in non-aromatic fuel for 7 days compared to a new shaft seal Na-3 not submersed in fuel, and a new seal Nf-3 also submersed in fuel. When allowed to dry, seal P 1-3 returned to near normal appearance and size. This condition may be due to a previous exposure to an unknown substance. The new elastomer that was stored in air only (not submersed in fuel) remained constant in mass weight and varied slightly in volume.

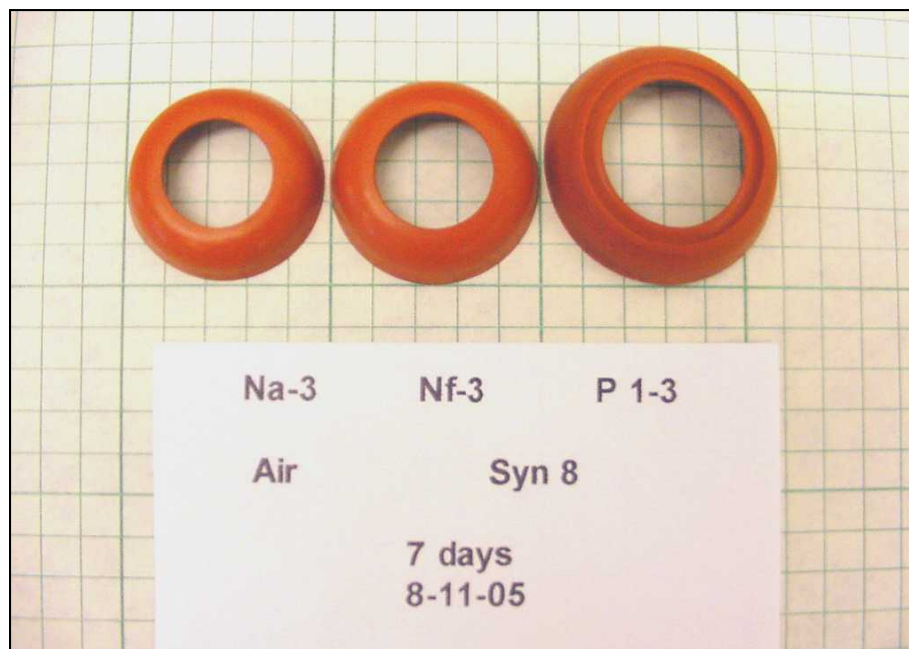


**Figure II-3. Stanadyne Injection Pump Calculated by Method A from Days 0-7, 0-28, 0-35, 0-56, 0-63, 0-84, 0-91, 91-112 to Obtain Cumulative Mass % changes in Fluorosilicone Elastomers in all Fuels**



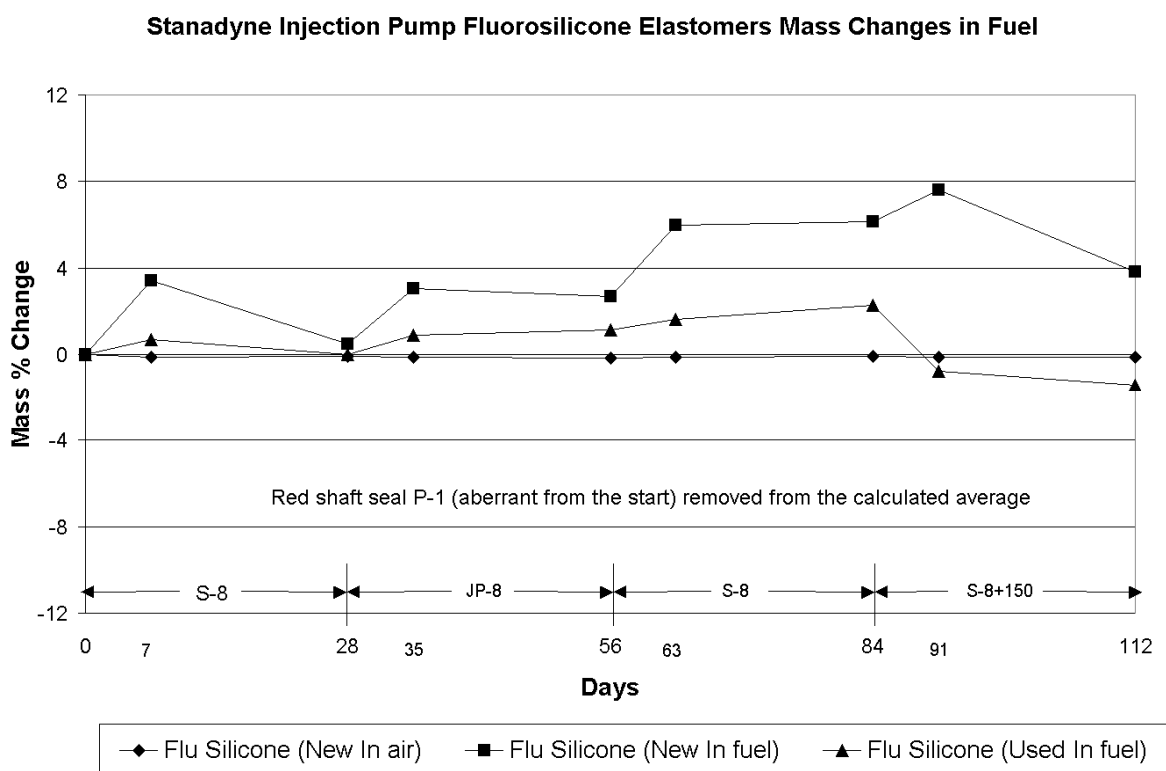


**Figure II-4. Stanadyne Injection Pump Calculated by Method A from Days 0-7, 0-28, 0-35, 0-56, 0-63, 0-84, 0-91, 91-112 to Obtain Cumulative Volume % changes in Fluorosilicone Elastomers in all Fuels**

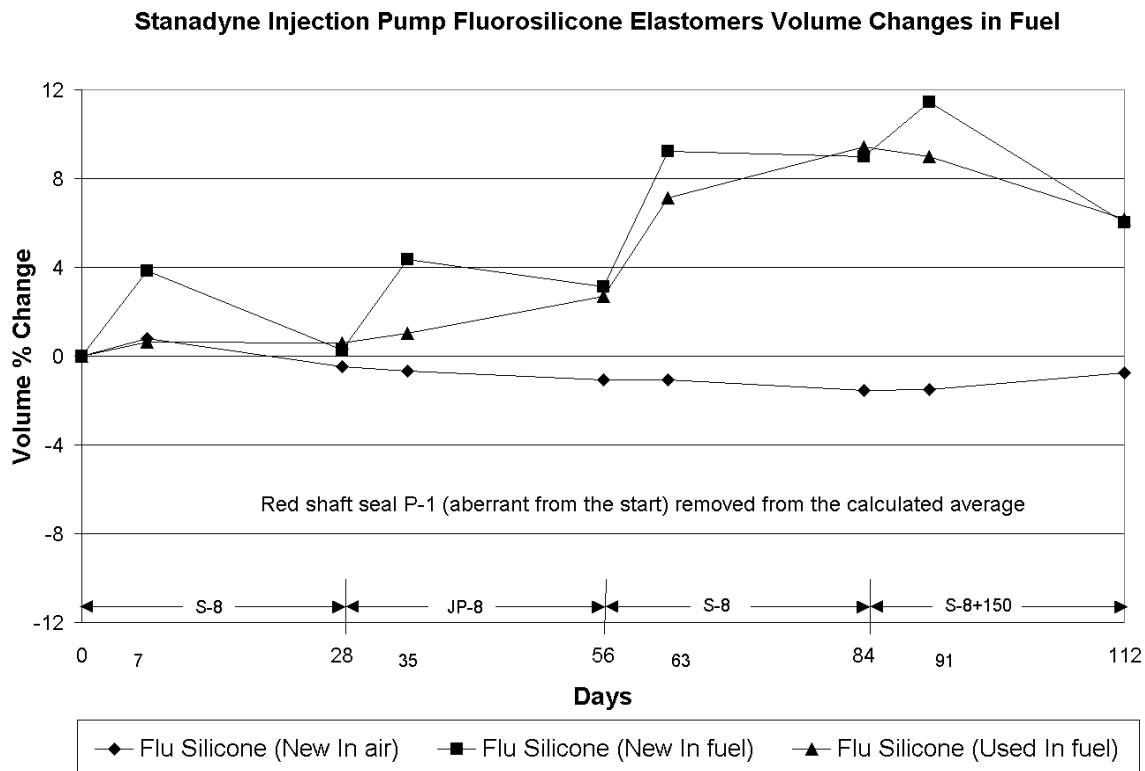


**Figure II-5. Fluorosilicone Drive Shaft Seals**

Figures II-6 and II-7 show the difference in mass and volume with the aberrant seal removed from the calculated average. This definitely presents a more realistic behavior of the averaged changes as the seals are immersed in the different fuels. With the used seal from pump No. 1 removed from the calculations, the increase in mass and volume are not as significant and the new submerged seals exhibit a greater mass and volume increase than the used seals. When exposed to the S-8 fuel additized with 15% aromatics, the new submerged seals reacted to a lesser extent than the used submerged seals; however, both seals paralleled one another in negative volume percent change.



**Figure II-6. Stanadyne Injection Pump Calculated by Method A from Days 0-7, 0-28, 0-35, 0-56, 0-63, 0-84, 0-91, 0-112 to Obtain Cumulative Mass % changes in Fluorosilicone Elastomers in Fuels. Aberrant Red Shaft Seal Removed from Calculated Average**



**Figure II-7. Stanadyne Injection Pump Calculated by Method A from Day 0-7, 0-28, 0-35, 0-56, 0-63, 0-84, 0-91, 0-112 to Obtain Cumulative Volume % changes in Fluorosilicone Elastomers in all Fuels. Aberrant Red Shaft Seal Removed from Calculated Average**

### 3.2 Bosch In-Line Pump

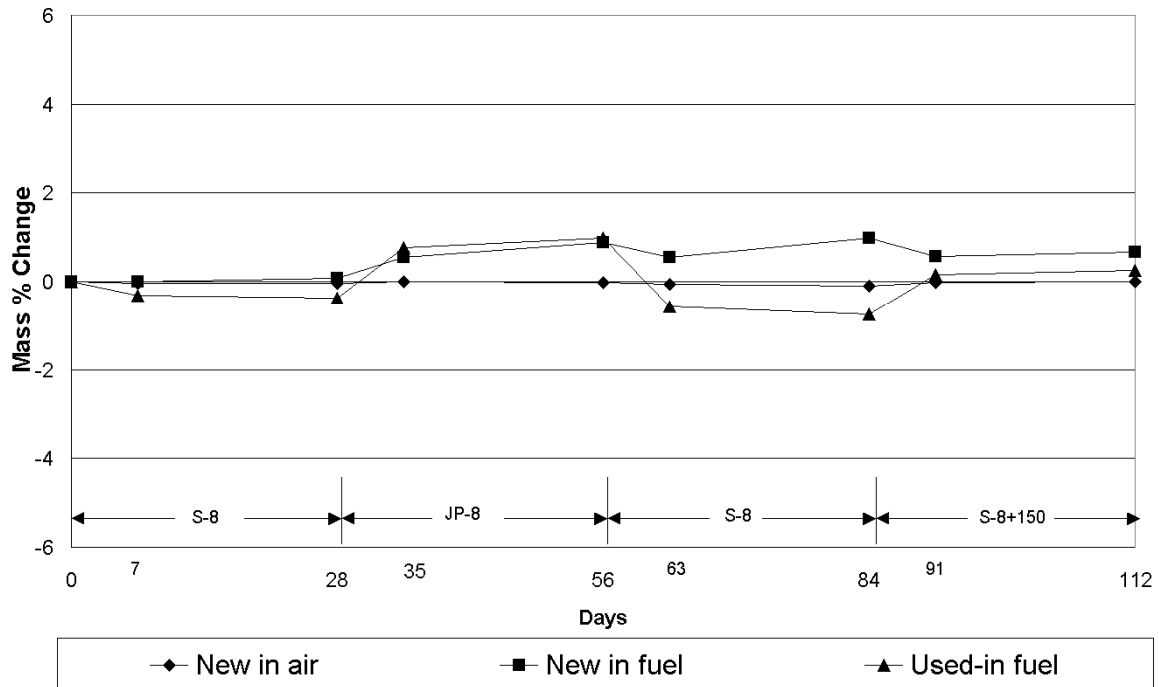
The response received when inquiry was made on the elastomer composition in the Bosch in-line injection pump used in the Cummins 8.3L engine was that the specific composition of the all the O-rings was not known but that all of the O-rings that come in contact with the fuel were made of BUNA rubber. The word BUNA was interpreted to mean Nitrile. As mentioned earlier, a seal that was reported to be Nitrile in the Stanadyne pump resulted to be Viton instead. Therefore, a set of new and used O-rings and seals for the Bosch in-line pump were tested for general elastomer composition identification using infrared spectroscopy. The results were that only one seal in the pump contained Nitrile rubber. Spectra showing the results of infrared waves can be seen in Appendix II-C. The rest of the O-rings consisting of barrel and fuel delivery valve seals are butadiene rubber. Figure II-8 shows a Nitrile encapsulated steel fuel gallery seal/washer used in the Bosh pump that has been cut to expose the metal washer inside the Nitrile material.



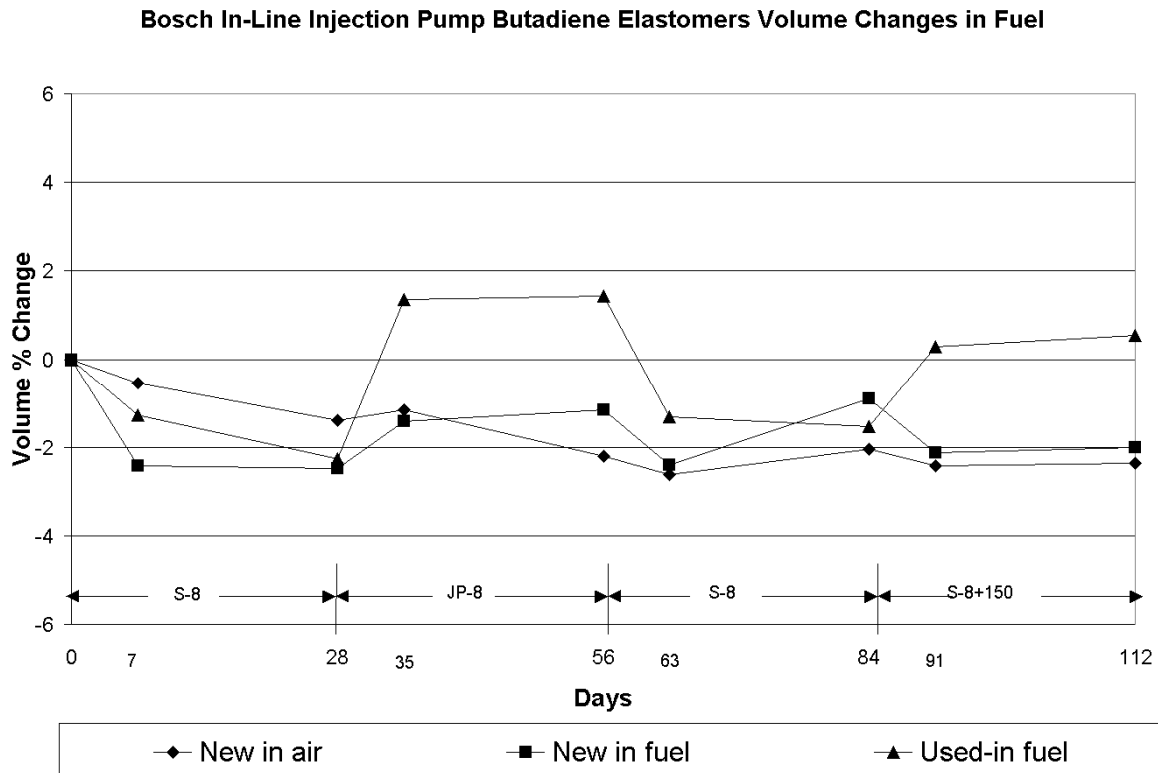
**Figure II-8. Nitrile Encapsulated Steel Fuel Gallery Seal/Washer  
Used in the Bosch Pump**

Figures II-9 and II-10 present the changes observed in the Butadiene O-rings of the Bosch in-line injection pump. As shown in Figure II-9, the new and used submersed elastomers exhibited only a slight variation in mass % change with any fuel. The most notable changes occurred after the seventh day submersion in all fuels. The volume changes seen in Figure II-10 exhibited the same pattern as mass percent changes, however, the new submersed seals, remained in the negative range between 1 and 2 percent while the used submersed seals show a 3.7% increase in volume from day 28 to day 35 and then a 2.4% volume loss from day 56 to day 63 after submersion in non-aromatic fuel. Notable is the unexpected increase in mass and volume for the new submersed elastomers from day 63 to day 84 when switched to non-aromatic fuel and then the loss of mass and volume in the new seals when switched to fuel additized with aromatics from day 84 to day 91. With the exception of the noted deviations, the submersed Butadiene elastomers behaved as expected. The new elastomers not submersed in fuel exhibited slight fluctuations in mass and volume.

### Bosch In-Line Injection Pump Butadiene Elastomers Mass Changes in Fuel

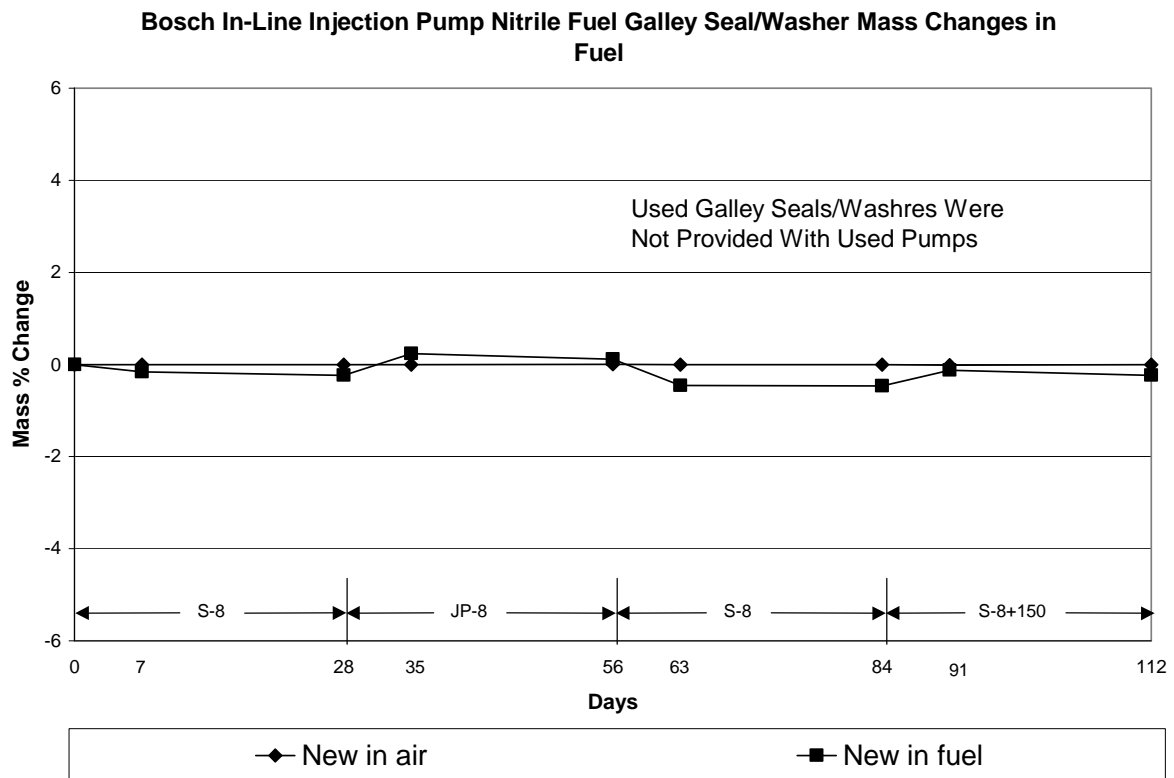


**Figure II-9. Bosch In-Line Injection Pump Calculated by Method A from Day 0-7, 0-28, 0-35, 0-56, 0-63, 0-84, 0-91, 0-112 to Obtain Cumulative Mass % changes in Butadiene Elastomers in all Fuels**

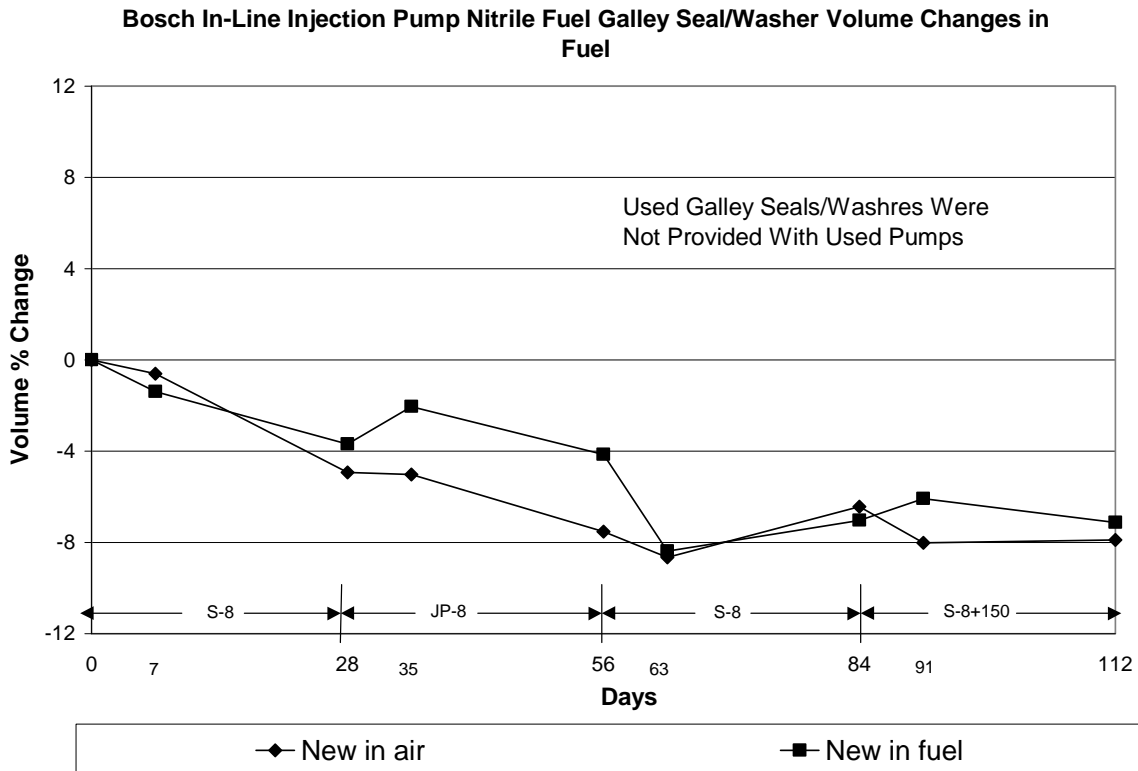


**Figure II-10. Bosch In-Line Injection Pump Calculated by Method A from day 0-7, 0-28, 0-35, 0-56, 0-63, 0-84, 0-91, 0-112 to Obtain Cumulative Volume % changes in Butadiene Elastomers in all Fuels**

Figures II-11 and II-12 present the mass and volume changes results of the Nitrile fuel galley seals that are used in fuel inlet and outlet lines of the injection pump. There were no used seals provided therefore, the charts show the changes in mass and volume of a new seal suspended in air and a new seal immersed in the non-aromatic and aromatic fuels. As seen in Figure II-11, mass changes were insignificant from day 1 to day 112. Volume changes seen in Figure II-12 however, spiraled negatively for the most part, regardless of the type of fuel used. The seal suspended in air paralleled the volume losses of the submerged seal and such behavior cannot be explained. It can be postulated that perhaps because the gallery seal is a metal washer encapsulated in Nitrile rubber, it may have reacted differently when exposed to 140°F heat in the oven.



**Figure II-11. Bosch In-Line Injection Pump Calculated by Method A from Day 0-7, 0-28, 0-35, 0-56, 0-63, 0-84, 0-91, 0-112 to Obtain Cumulative Mass % changes in Nitrile Elastomers in all Fuels**

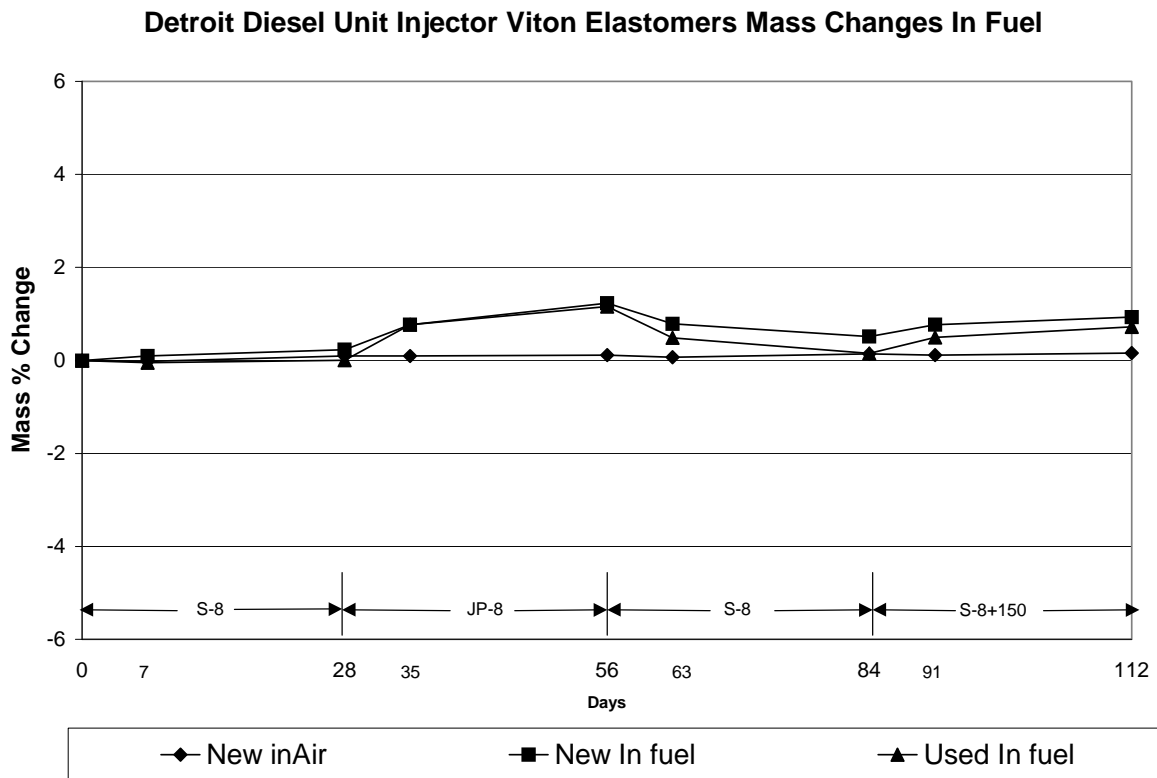


**Figure II-12. Bosch In-Line Injection Pump Calculated by Method A from Day 0-7, 0-28, 0-35, 0-56, 0-63, 0-84, 0-91, 0-112 to Obtain Cumulative Volume % changes in Nitrile Elastomers in all Fuels**

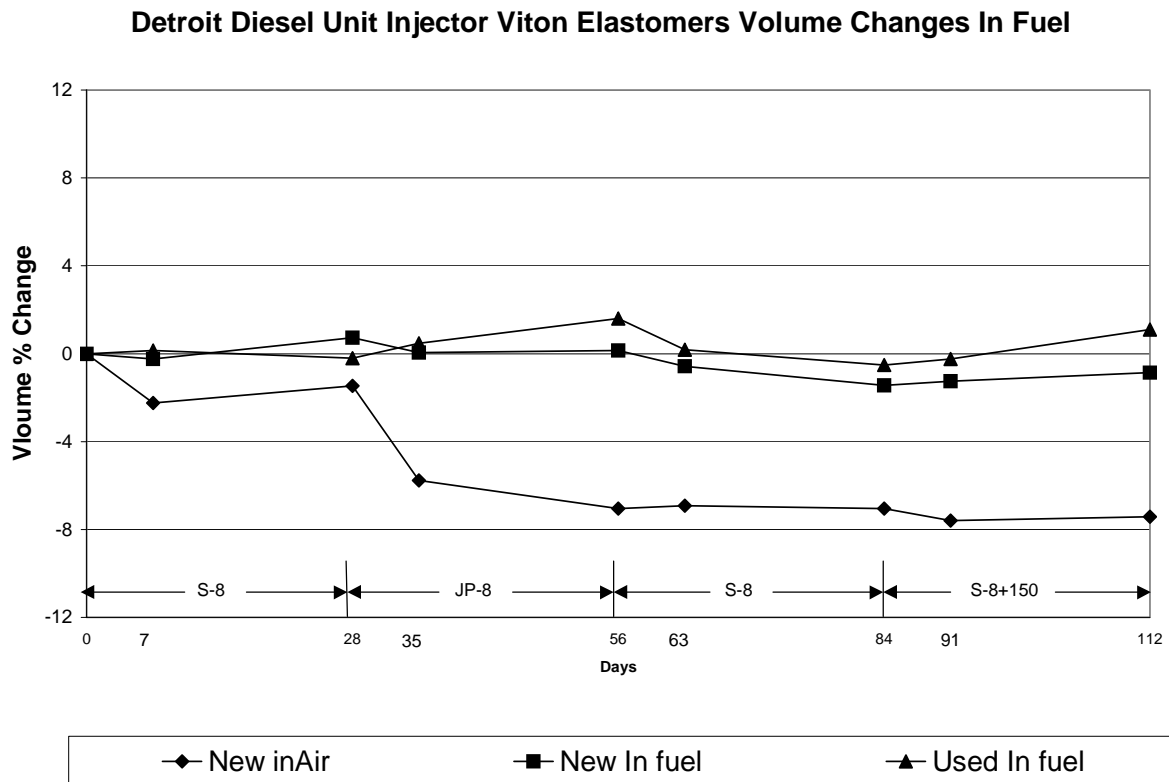
### 3.3 Detroit Diesel Unit Injector

Figures II-13 and II-14 present the changes observed in the Viton O-ring found in Detroit Diesel Unit Injectors. As shown, there is a maximum two-percent variance in mass and volume percent change with any of the fuels. The submerged new and used O-rings actually show a slight increase in mass from day 0 to day 28 in non-aromatic fuel, instead of the expected decrease. From day 28 to day 56 when the O-rings were switched to aromatic fuel, the data shows an increase in mass for both the new and used O-rings; however, Figure II-14 shows a decrease in volume of approximately two percent for new submerged O-ring. From day 56 to day 84 when switched to non-aromatic fuel, decreases in mass and volume were observed. During the last switch to aromatic fuel, from day 84 to day 112, a definite increase in mass and volume can be seen. For the most part, the elastomers behaved as expected during the switching between fuels. The approximately 8 percent volume loss in the seal suspended in air is believed to be an erroneous reading in weight that occurred at the beginning of the test.





**Figure II-13. Detroit Diesel Injection Pump Calculated by Method A from Day 0-7, 0-28, 0-35, 0-56, 0-63, 0-84, 0-91, 0-112 to Obtain Cumulative Mass % changes in Viton Elastomers in all Fuels**



**Figure II-14. Detroit Diesel Injection Pump Calculated by Method A from Day 0-7, 0-28, 0-35, 0-56, 0-63, 0-84, 0-91, 0-112 to Obtain Cumulative Volume % changes in Viton Elastomers in all Fuels**

#### 4.0 CONCLUSIONS AND RECOMMENDATIONS

Results from switching new and used field elastomers from selected fuel injection systems between non-aromatic and aromatic fuels conclude that seals containing fluorocarbon (Viton) material exhibited the least amount of mass and volume percent loss and gain. The variations seen in this study indicate that Viton elastomers would be the least likely to be impacted negatively when switched between synthetic and petroleum derived fuels.

The elastomers containing butadiene material behaved as expected in that with noted exceptions, mass and volume percent losses occurred when seals were submerged in non-aromatic fuel and conversely, mass and volume percent gains occurred when elastomers were switched to aromatic fuel. The new submerged elastomers exhibited peculiar behavior in that the elastomers exhibited volume losses and gains when switched between fuels as expected; however, all changes were in the negative range from starting volume value. The volume swings between fuel switches in the

used elastomers were below the starting value with synthetic fuel and above starting values with JP-8 and S-8 additized with aromatics. The losses and gains were within two percent from starting values. Although mass and volume percent changes in new and used submerged elastomers did not exceed three percent it cannot be concluded that butadiene elastomers will not be negatively impacted with non-aromatic synthetic fuel.

Fluorosilicone elastomers exhibited the largest mass and volume increases in both non-aromatic and aromatic fuels. Definite gains and losses were observed; however, all were in the upper range from starting values except for the mass change in the used seals during the last switch to aromatic fuel from day 91 to day 112. The largest increases in mass and volume percent occurred during the first seven days of every fuel switch. In the application of the Fluorosilicone seals in the Stanadyne pump, the eleven plus percent volume increase seen in the submerged seals should not present a problem with non-aromatic fuels.

The Nitrile fuel gallery seal/washer in the Bosch in-line injection pump showed the largest volume percent loss of all the seals tested. As reported in previous studies [4, 6], Nitrile elastomers exhibited large volume swings in swell with switches between non-aromatic and aromatic fuels. In this evaluation, there were definite swings in swell occurring between fuel switches; however, all were below the starting value, which would indicate that continuous fuel switching could become a problem in the long run. Unfortunately there were no used seals furnished for testing and an accurate estimate of how used seals will behave in non-aromatic fuels could not be made.

In an effort to evaluate the total cumulative effect of switch-loading elastomers between non-aromatic and aromatic fuel, mass and volume percent changes from day 1 to day 112 were averaged for each elastomer group. Interestingly the data shows that new submerged elastomers reacted to fuel switch loading to a greater degree than did the used elastomers. Table II-4 shows the results of the cumulative effect of elastomer switch loading.

<b>Table II-4. Averaged Total Changes in Elastomer Mass and Volume % Weight When Switch-Loaded Between Non- Aromatic and Aromatic Fuels</b>			
<b>Stanadyne Pump</b>			
	<b>New in Air</b>	<b>New in Fuel</b>	<b>Used In Fuel</b>
Mass, Viton	0.055	-0.175	0.061
Volume, Viton	0.876	-0.630	-0.413
Mass, Fluorosilicone	-0.115	4.145	0.555
Volume, Fluorosilicone	-0.788	5.919	4.587
<b>Bosch Pump</b>			
Mass, Butadiene	-0.035	0.535	0.020
Volume, Butadiene	-1.845	-1.862	-0.305
Mass, Nitrile	0.003	-0.165	(none provided)
Volume, Nitrile	-6.139	-4.985	(none provided)
<b>Detroit Diesel Injector</b>			
Mass, Viton	0.096	0.664	0.467
Volume, Nitrile	-5.692	-0.434	0.314

It is recommended that further switch-loading investigations be conducted with Nitrile elastomers and include used elastomers in order to determine the absolute effect of the mass and volume losses seen in this investigation.

## **5.0 REFERENCES FOR TASK II**

1. Cuellar, J., Jr., Tosh, J., "Effect of Cyclic Fuel Exposure on Elastomer Properties," Letter Report BFLRF No. 237, Southwest Research Institute, August 1987.
2. Frame, E.A., Marbach, H.W., Jr., Childress, K.H., Yost, D.M., and Westbrook, S.R., "Operability and Compatibility Characteristics of Advanced Technology Diesel Fuels," SwRI Project No. 03-02476, January 2002.
3. Muzzell, P., Stavinoha, L., Villahermosa, L., Chapin, R., and McKay, B., "Synthetic JP-5 Aviation Turbine Fuel Elastomer Compatibility," TARDEC Report No. 13978, November 2003.
4. Muzzell, P., Stavinoha, L., and Villahermosa, L., "Elastomer Impact When Switch-Loading Synthetic and Petroleum Fuel," TARDEC Report No. 14037, March 2004.
5. Muzzell, P., Stavinoha, L., and Chapin, R., "Synthetic Fischer-Tropsch (FT) Aviation Turbine Fuel Elastomer Compatibility," TARDEC Report No. 15043, February 2005.

6. Muzzell, P., Stavinoha, L., Villahermosa, L., Sattler, E., and Terry, A., "Elastomer Impact When Switch-Loading Synthetic Fuel Blends and Petroleum Fuels," TARDEC Report No. 16028, July 2006.
7. Muzzell, P.A., et al., "Properties of Fischer-Tropsch (FT) Blends for Use in Military Equipment," SAE Paper No. 2006-01-0702, 2006.

### **III. TASK III: COLD STARTING PERFORMANCE OF JP-8: FISCHER-TROPSCH DERIVED VERSUS PETROLEUM DERIVED**

#### **1.0 BACKGROUND**

The One Fuel Forward scenario for operations dictates that the U.S. Army utilizes JP-8 specification aviation turbine fuel in all diesel powered ground equipment. Petroleum derived JP-8 performs well in diesel engines under most conditions. One classical diesel engine performance issue is poor cold starting due to low cetane number fuel, such as JP-8. Although the U.S. Army is currently not voicing any issues regarding cold start performance, JP-8 fuel cetane numbers can be frequently below 40, the minimum value specified by most engine manufacturers. Because of impacts on JP-8 supplies for aviation, a minimum cetane number specification for JP-8 to improve diesel engine performance is not likely to occur.

In order to reduce reliance on imported petroleum, the DOD is looking at fuels that can be made from a domestic feedstock such as natural gas or coal. The Fischer-Tropsch process can be used to convert a domestic feedstock into a liquid fuel that can be refined to match JP-8 characteristics. JP-8 fuels derived from Fischer-Tropsch liquids have inherently high cetane numbers. Thus Fischer-Tropsch derived JP-8 has the potential to alleviate the diesel engine cold starting issues with a JP-8 specification fuel.

#### **2.0 OBJECTIVE**

Determine potential benefits of the increased cetane number of Fischer-Tropsch derived JP-8 fuel on the cold start performance of a representative Army diesel engine.

### 3.0 DISCUSSION

The impact of cetane number on cold starting of diesel engines has been the subject of numerous studies [1–5]. Diesel engines are inherently more difficult to start at low temperatures than gasoline engines. Where a gasoline engine will start reliably at -20°F to -35°F, a diesel engine may have difficulty at 0°F. This situation becomes more pronounced as the cetane value of the fuel decreases. As temperature decreases, diesel engines that exhibit cetane number related cold start issues tend to exhibit extended cranking intervals, excessive white smoke, and idle roughness. Extended cranking interval leads to reductions in battery and starter life in addition to reduction in life of cold start systems. White smoke, attributed to unburned hydrocarbons passing through the engine, has an objectionable smell and contributes to ozone and smog formation. Idle roughness impacts warm up time and drivability. Under combat conditions, all of these issues become more critical. Initial data on GTL fuels indicates that diesel engines will start at lower temperatures, idle quieter, and emit less or no smoke. This data, however, has not been verified in engines typically used by the military.

Indirect Injection (IDI) diesel engines are prevalent in military vehicles. Due to high combustion chamber surface to volume ratios (associated with increased heat transfer,) IDI diesel engines typically need a high compression ratio to help with cold start. The primary component of a cold start system on an IDI engine is typically a glow plug within the combustion chamber, which is used to preheat the air charge. An example of an IDI engine in the DOD is the 6.5L engine that powers the M998 HMMWV. The health of the cold starts systems play a critical role for cold start with marginal cetane number fuels in the 6.5L engine. The cold start systems include the glow plugs, a glow plug timer circuit, a cold start advance solenoid for the fuel injection pump, and the fuel. A temperature switch located in the cooling jacket activates the cold start advance solenoid circuit. A recent modification for JP-8 use in hot climates allows cold start advance when the engine is sufficiently warm. The cetane number and viscosity of the fuel plays an important role in cold start of the engine. A higher cetane number fuel is a more reactive fuel, and requires a lower combustion chamber temperature for autoignition to occur. The viscosity of the fuel can inhibit the metering at cold temperatures and may also alter injection timing. All factors mentioned can contribute to the cold start performance of the HMMWV.

## 4.0 APPROACH

Due to the number of HMMWVs in the military fleet, it was proposed to use a 6.5L engine to evaluate the cold start performance of FT JP-8 with respect to petroleum JP-8. An additional fuel under consideration would be a 50% blend of S-8 with JP-8.

The technical approach was to:

- Instrument and install the engine in a cold chamber. Mount the engine with a battery and alternator so that the glow plug based cold start system is fully operational.
- The best approach was to reliably crank the engine at a consistent speed to evaluate fuels differences. It was recommended not using batteries because variations in cranking system performance (battery and starter condition) can mask fuel property effects. At the lowest start temperature determined for each fuel using the cranking system, start attempts were then made using a battery/starter system.
- The engine Technical Manual [6] was consulted to determine the range of recommended cranking duration, cranking speeds, and repeats intervals for start attempts. Three start attempts will be made before declaring failure to start. Engine stall after starting will be considered a measure of poor idle quality, and an additional attempt to start will be made.
- Monitor test parameters that indicate starting quality, which may include but not be limited to, the time to start, revolutions to start, time to temperature, idle speed, and idle quality.
- Monitor coolant temperature, head temperature near the pre-combustion chamber, cranking speed, cranking time to start.
- Chart speed versus time during test to know how steady or unsteady the idle is.
- Investigate exhaust smoke for opacity and unburned hydrocarbons. Exhaust opacity and unburned hydrocarbons traces were recorded.

## 5.0 EXPERIMENTAL RESULTS

A naturally aspirated General Engine Products 6.5L indirect injection diesel engine was prepped for the Fischer-Tropsch derived JP-8 cold start testing. The engine was mounted on a stand and attached to a constant-speed cranking system. The cranking system contained an over-running clutch that allowed the engine to accelerate once started.

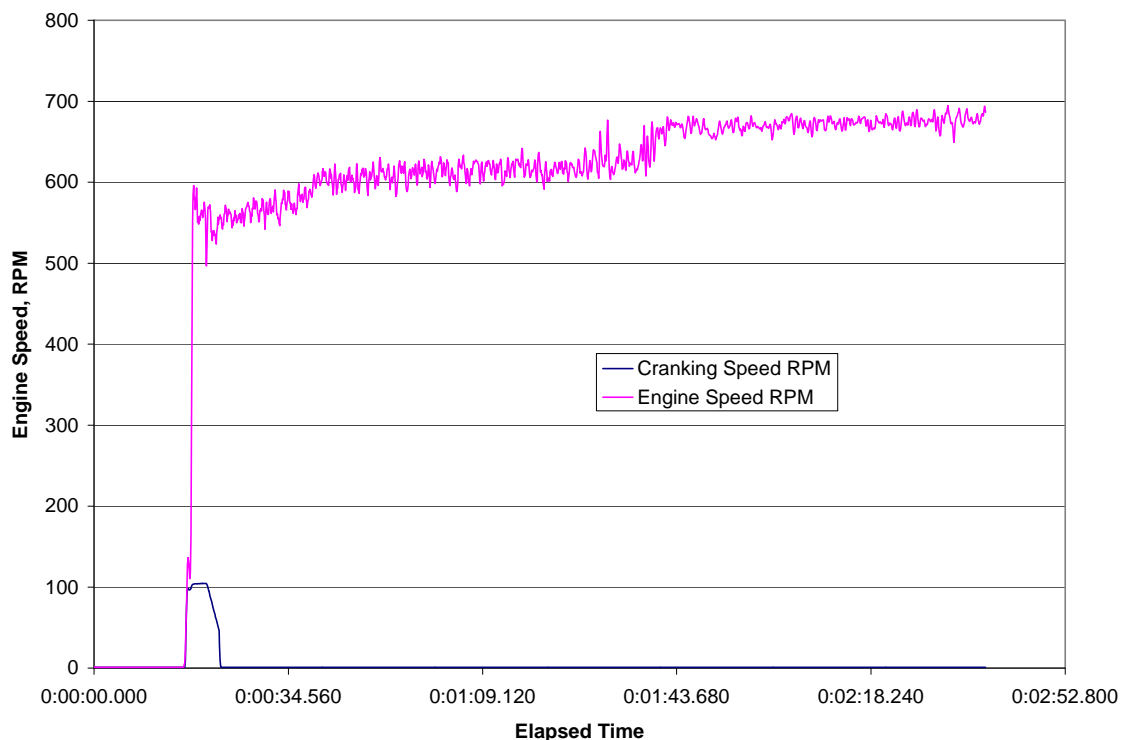
The 6.5L engine utilizes a cold start system that activates the glow plugs for a scheduled period of time based on coolant temperature. In addition a fast-idle setting and a cold-start fuel injection advance are implemented when the coolant temperature is below 38°C. During cold temperatures the glow plugs may be activated even after the engine starts to help reduce white smoke and improve warm-up times. SwRI determined that the cold start components used on a fielded HMMWV differed from the cold start test engine. Efforts were made to obtain the current production HMMWV components, however issues about SwRI purchasing military only items arose. The cold start components from an older 6.2L version of the engine were available and SwRI felt that as long as the cold start components are consistently activated between the test fuels at each test temperature, the fuel effects on starting and engine warm up data should be comparable.

The cold chamber for the testing had been serviced and prepped for testing. The engine was installed in the cold chamber along with the cranking motor. Unfortunately the system initially had trouble maintaining temperatures below zero degrees Fahrenheit and a new expansion valve and compressor valve rebuild was required. The insulation of the box was augmented with an additional 2-inches of expanded polystyrene. Reliability issues existed with the cold box throughout testing.

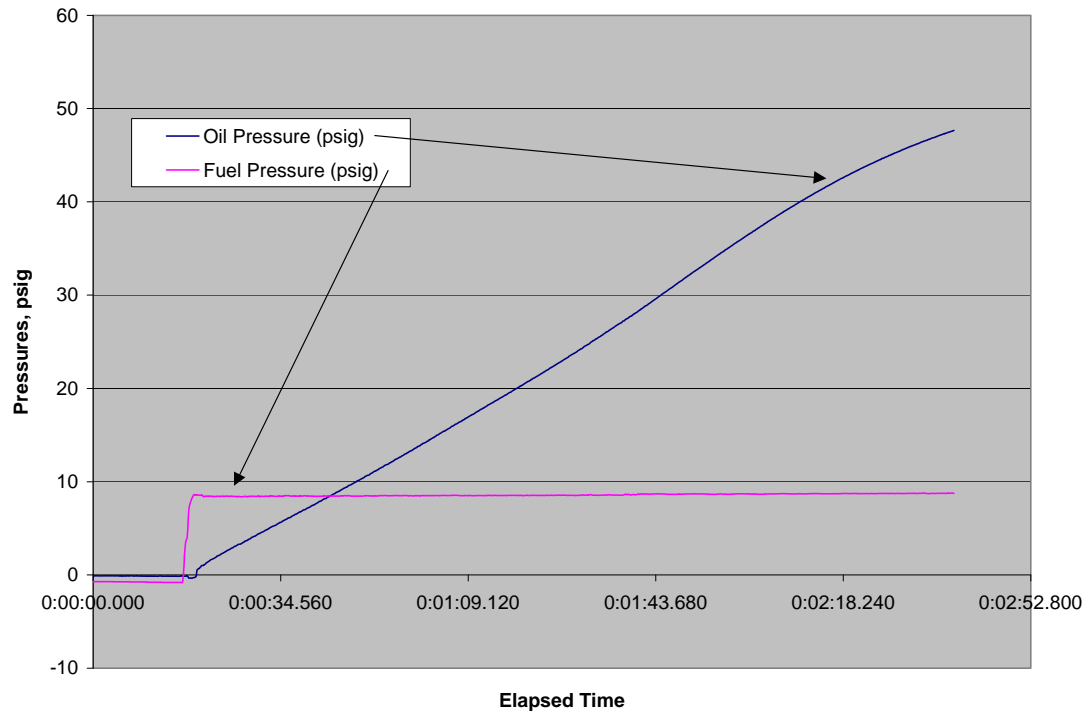
At the lowest temperature attained in the cold box, -28°C, the engine operating on JP-8, and a fully active glow plug system, the engine started in less than two seconds with the engine cranking at 200-RPM. Review of the engine Technical Manual indicated that 100-RPM is the minimum cranking speed allowable for an operable starting system. The variable speed drive was adjusted to 100-RPM to simulate a marginal starting system. Although the engine started quickly on JP-8 at -28°C, it did stumble while warming up. During the warm-up it was noted the fast idle solenoid was not raising the engine speed. It was found the rack return spring was too stiff for the solenoid to push the rack lever over center. Efforts were made to properly affect the fast idle function and to stabilize the cold box performance.



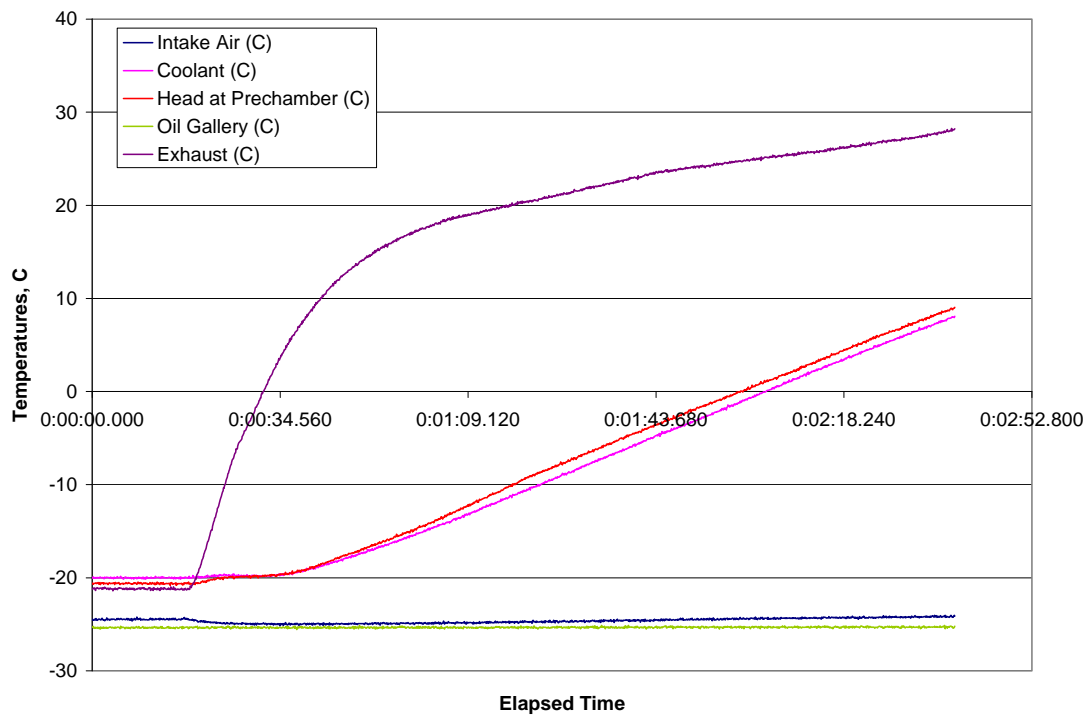
Plots of cold start performance for JP-8 at -27°C are shown in the following figures. The starts were performed with the cold start aids activated and the engine cranking speed set at 100-RPM. Figure III-1 shows the cranking motor speed and the engine speed. The engine appears to start shortly after the cranking speed reaches 100-RPM. The engine does run rough and stumble for about 1-minute and 45-seconds then the engine speed shifts and the engine smooths out. The speed shift may occur due to the fast idle becoming effective. Figure III-2 shows the fuel and oil pressures during the engine start and warm up. The fuel pressure reaches a steady value after a few seconds. The oil pressure takes almost two minutes to reach 30-psig, even with the OEA-30 Arctic lubricant. Figure III-3 shows the monitored temperatures during the course of the start and operation period.



**Figure III-1. Engine and Cranking Speeds with JP-8 at -28°C**

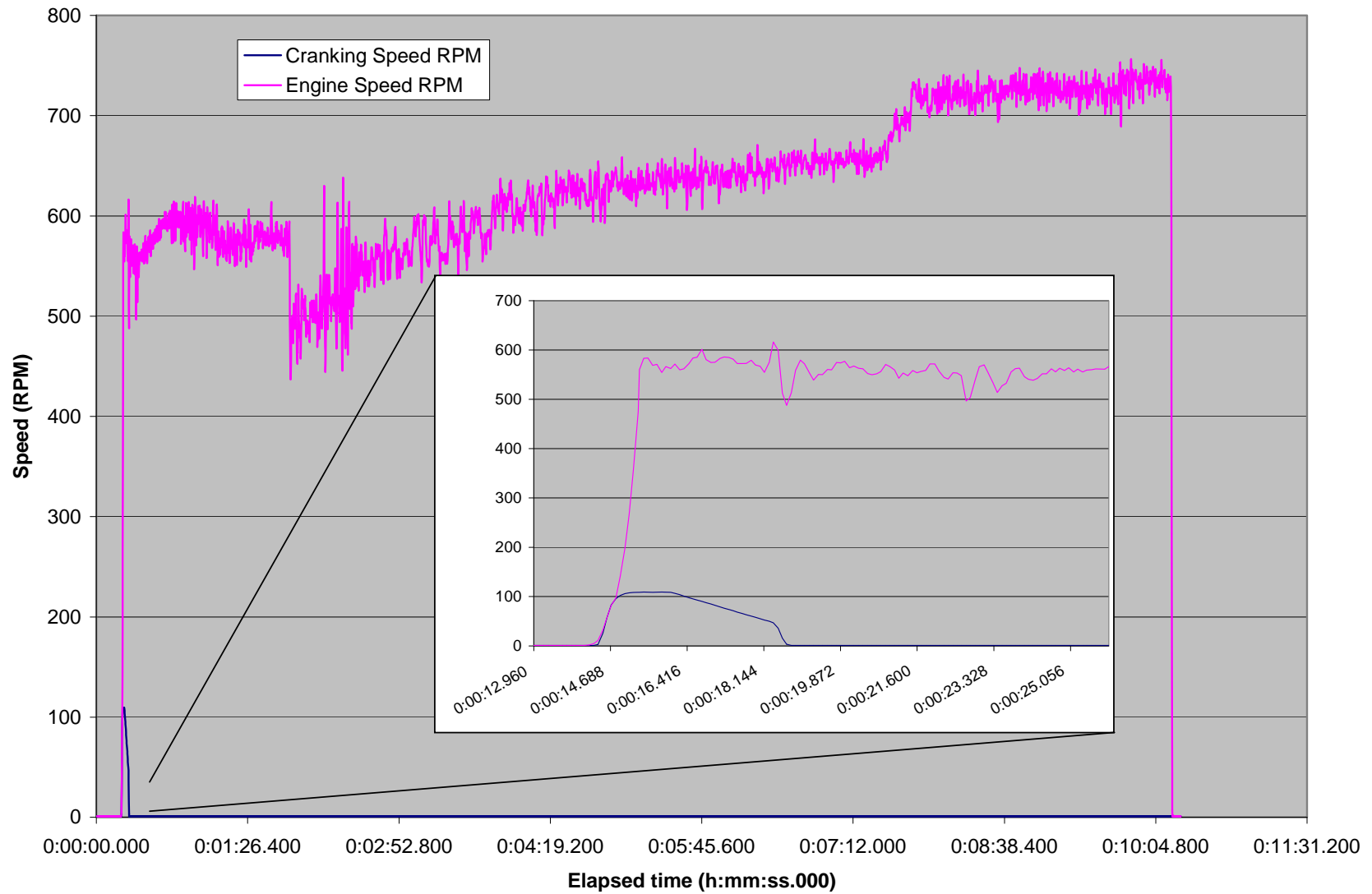


**Figure III-2. Fuel and Oil Pressures with JP-8 at -28°C**



**Figure III-3. Temperatures during Start and Warm-Up Period with JP-8 at -28°C**

The cold box temperatures plateau was in the  $-25^{\circ}\text{C}$  to  $-29^{\circ}\text{C}$  range and would not go any colder. Plots of cold start performance for JP-8 at  $-25^{\circ}\text{C}$  are shown in the following figures for a cold start with aids, and the engine cranking speed set at 100-RPM. These forms of the following plots are typical for the test runs with each of the test fuels. Figure III-4 shows the cranking motor speed and the engine speed, with a blow-up of the cranking interval. The engine appears to start shortly after the cranking speed reaches 100-RPM. The engine does run rough and stumble. At about 1-minute and 30-seconds the engine severely stumbles, and then gradually recovers. The change in engine speed at approximately 7-minutes and 30-seconds occurs when the temperature switch that controls the cold start advance and fast idle opens at around  $38^{\circ}\text{C}$ . The run is terminated when the coolant reaches  $54^{\circ}\text{C}$ , which is the temperature at which the glow plugs no longer function. Figure III-5 shows the exhaust opacity and unburned hydrocarbons tracking during the interval of rough engine operation, then clear up when the engine runs smooth. During this period white smoke was noted. It was anticipated that during the white smoke period the unburned hydrocarbons would be very high which proved to be the case. Figure III-6 shows the temperature and oil pressure histories during the cold start run.



**Figure III-4. Starting with Glow Plugs Activated with JP-8 at -25°C**

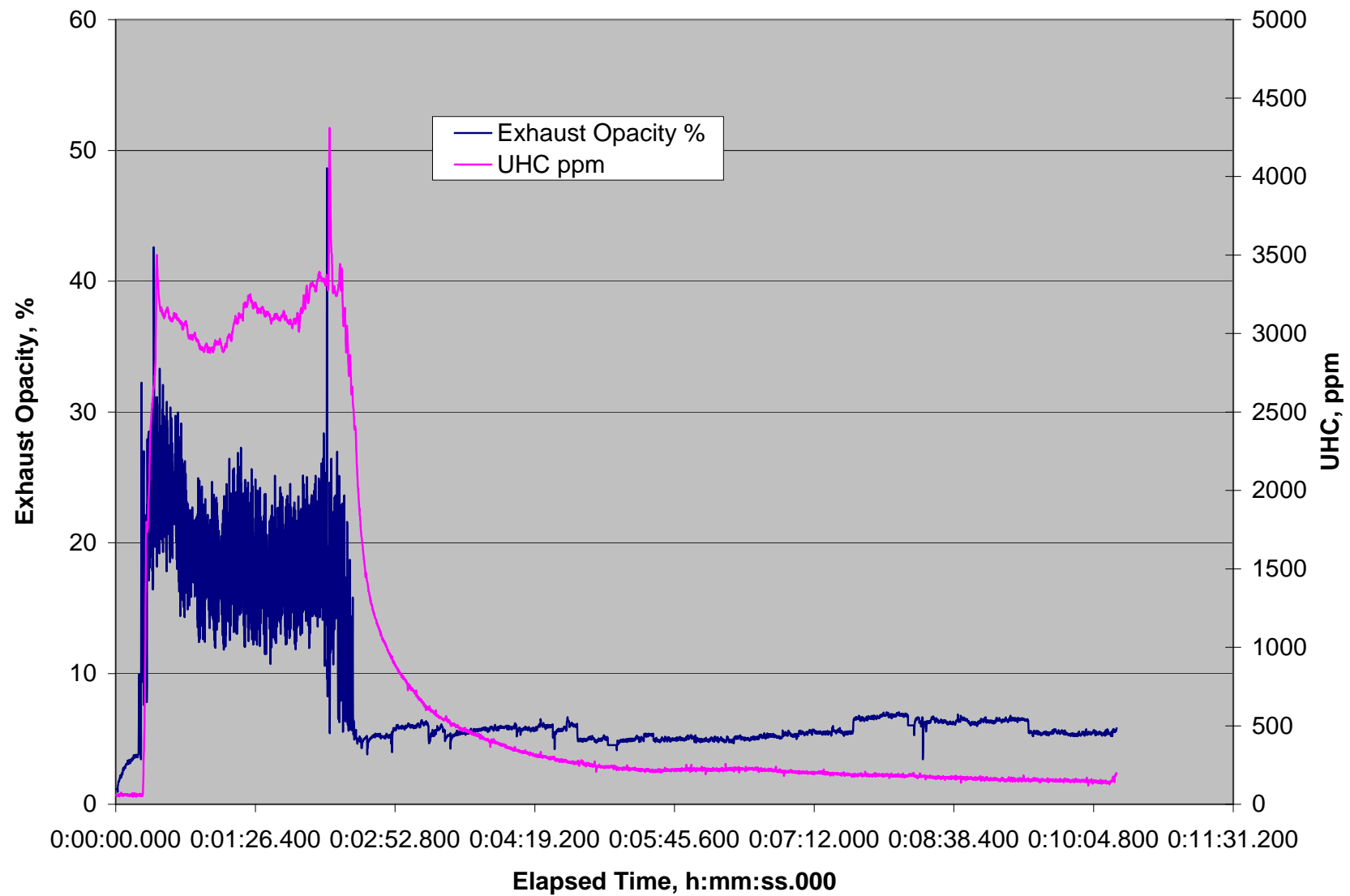


Figure III-5. Exhaust Opacity and Unburned Hydrocarbons with JP-8 at -25°C

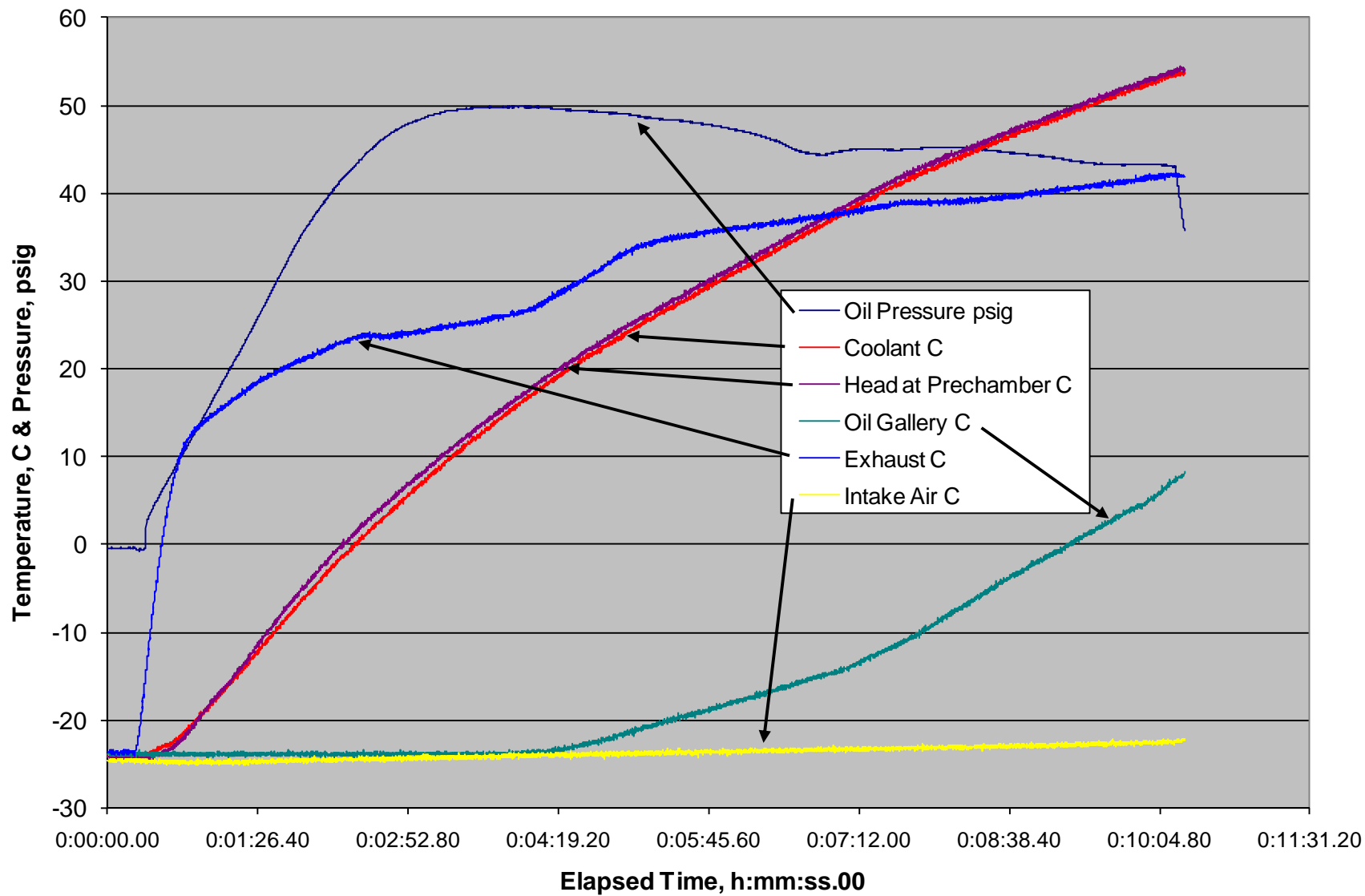


Figure III-6. Plots of Temperatures and Oil Pressure with JP-8 at -25°C

Plots of cold start performance for JP-8 at  $-25^{\circ}\text{C}$  are shown in the following figures for a cold start without glow plug activation, and the engine cranking speed set at 100-RPM. Figure III-7 shows the cranking motor speed and the engine speed for 4 start attempts without glow plugs and a final attempt with the glow plugs activated. Included in Figure III-7 are the Exhaust Opacity and Unburned Hydrocarbons (UHC) traces. The Exhaust Opacity peaks during the cranking intervals while the UHC appears to accumulate in the exhaust, eventually exceeding 20,000-ppm. The UHC result during the non-cranking intervals may be skewed by transport delays, raw fuel in the exhaust stack, and raw fuel trapped on the instrument filter. Figure III-8 shows the temperature histories during the cold start attempts without glow plugs. The exhaust temperature traces suggest there may be residual heat in the cylinder from each previous attempt because the temperature does not drop drastically. The thermal inertia of the thermocouple may also result in the exhaust temperature being consistent during the non-cranking periods. Even though the cylinders appear to get warmer with successive cranking events, the glow plugs are eventually needed to start the engine.

Plots of cold start performance for JP-8 and S-8, around  $-27^{\circ}\text{C}$ , are shown in Figures III-9 and III-10 for a cold start with aids, and the engine cranking speed set at 100-RPM. Figure III-9 is a plot of the engine speed and exhaust measurements for the JP-8 fuel. The exhaust opacity with JP-8 peaked at around 65-percent, due to black smoke, then white smoke was prevalent at 20 to 30-percent opacity, while the engine speed surged. During the period of high exhaust opacity, the unburned hydrocarbons were also high, with a peak of 3000-ppmC. Once the engine speed stabilized, both the exhaust opacity and unburned hydrocarbons dropped. Figure III-10 is a plot of the exhaust parameters for the S-8 fuel. Both fuels started the engine quickly with the glow plugs activated, but the content of the exhaust was much different with the S-8 fuel. With the S-8 fuel, white smoke was almost non-existent, and the unburned hydrocarbons peaked quickly at around 490-ppmC, then tapered off. The exhaust opacity did peak at 33-percent with S-8, but it was noted that as the 6.5L engine started a puff of black smoke was emitted with both fuels. This may have been due to fuel hitting the hot glow plug which cycles on and off during cranking and warm-up. With the S-8 fuel the engine took approximately 2-seconds from initiation of cranking to reach a stabilized engine speed of 600-RPM. With the JP-8 fuel the engine took 30-seconds to reach the same stabilized speed. These plots are typical for each fuel at the same test temperature with glow plugs activated.

After the initial trials to determine the test stands ability to differentiate between test fuels, a setback occurred during the cold start testing. Usually the oil pressure takes approximately one minute to reach a stable pressure. During a start it was noted that the S-8 fuel warmed up significantly faster than the JP-8 fuel. Investigations revealed low to non-existent oil pressure during the fast warm-up

test. The lubricating system and oil pressure sensor was investigated. It was determined that the cold start testing causes water to accumulate in the oil sump from the blow by, and that the lubricant never reaches a hot enough temperature to drive off the water. In addition, the water does not emulsify with the oil, and due to density the water sits below the lubricant in the pan. It appeared that a section of ice was sucked up to the oil pump intake and blocked oil from the pump, and subsequently the oil galleries. This resulted in two of the main bearings spinning, damaging the bearing caps and the crankshaft main journals.

Another block from a 6.5L engine available at TFLRF had severe bore wear and bore corrosion. An engine long block was located from another SwRI department that was considered surplus. The fuel injection system, intake and exhaust manifolds, and cold starting system were installed on the engine from the previous test engine. The engine had previously been used as a soot wear test engine so several cycles of flush and fill were performed to remove all old lubricant from the engine. The engine has been installed in the cold box and all connections, operation, and instrumentation verified. Efforts were made to periodically drain and replace the lubricant during testing to remove any collected water.



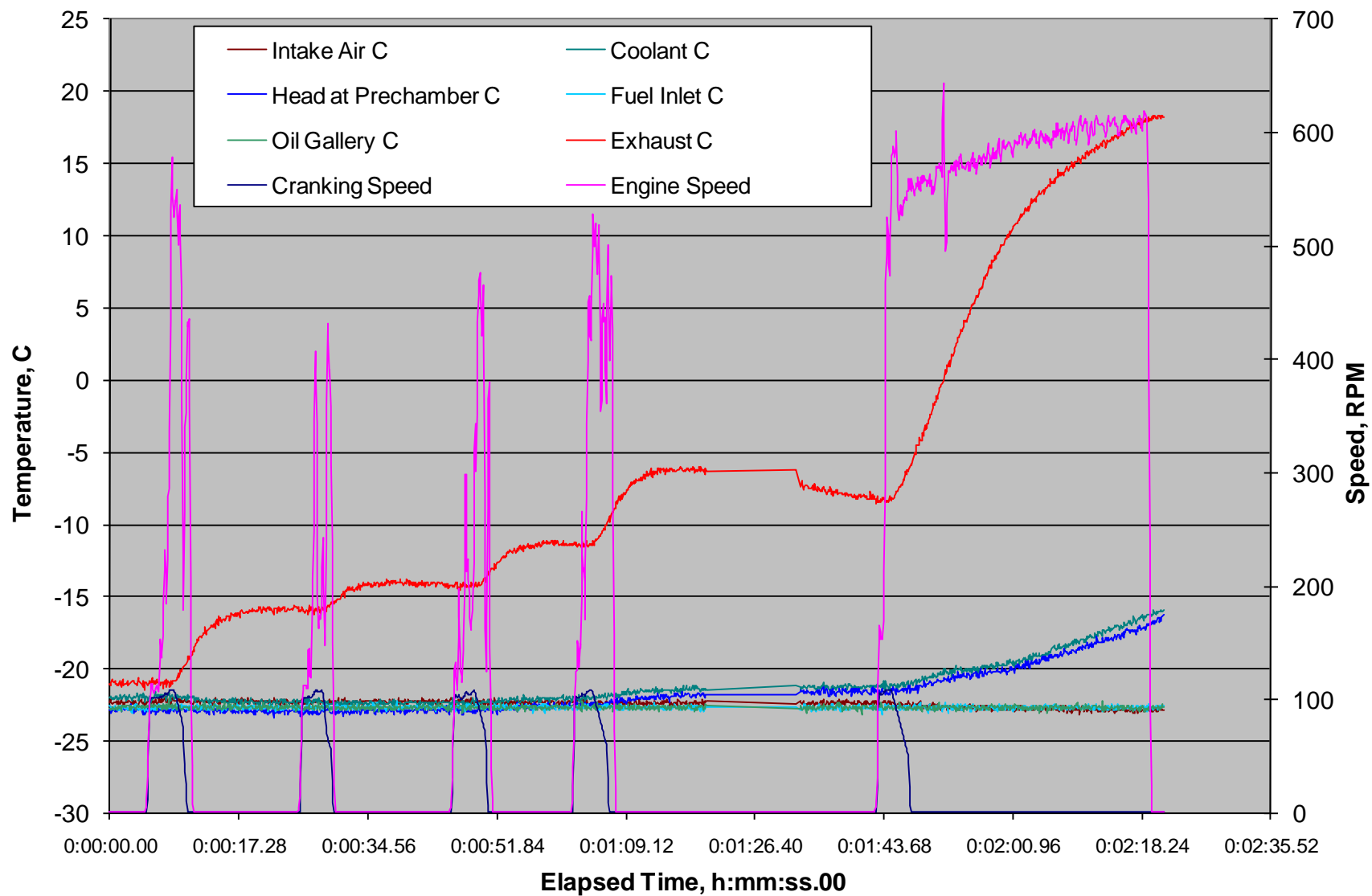


Figure III-7. Glow Plug Effects on Cold Start with JP-8 at -25°C

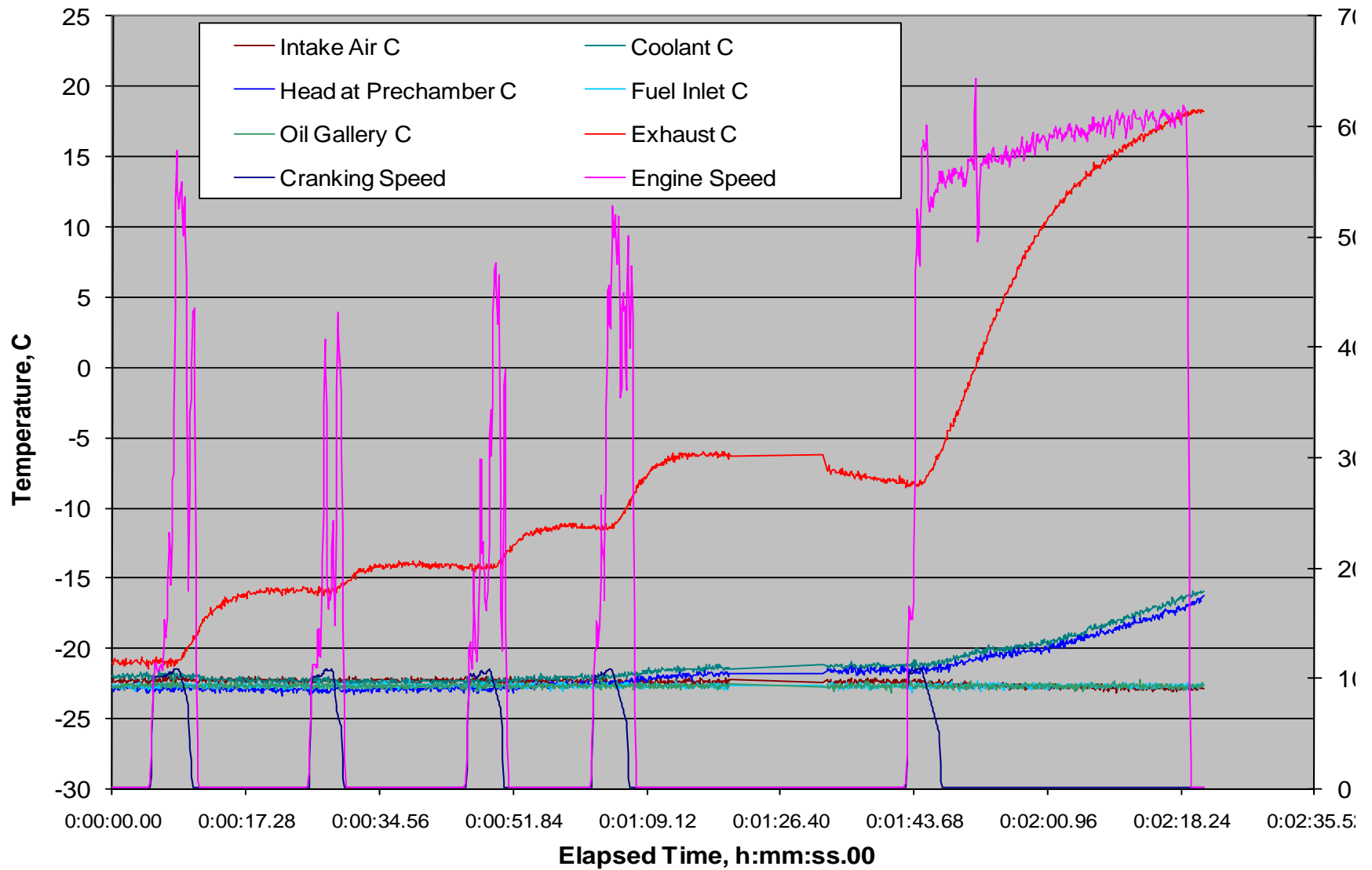
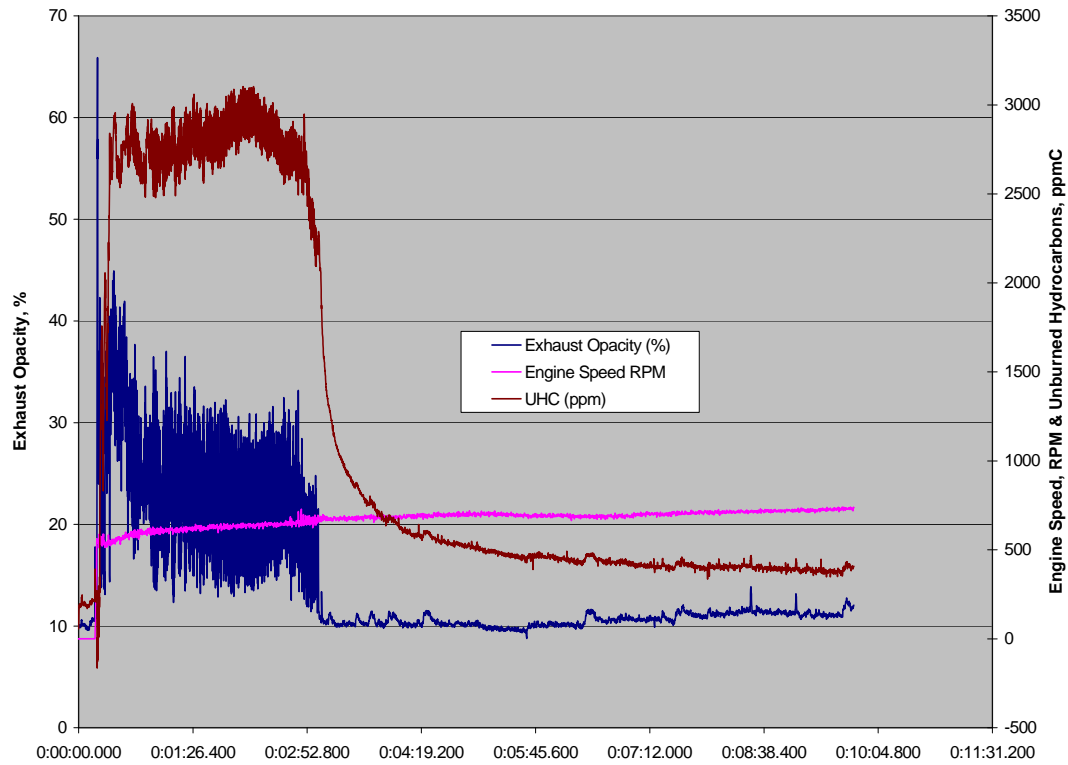
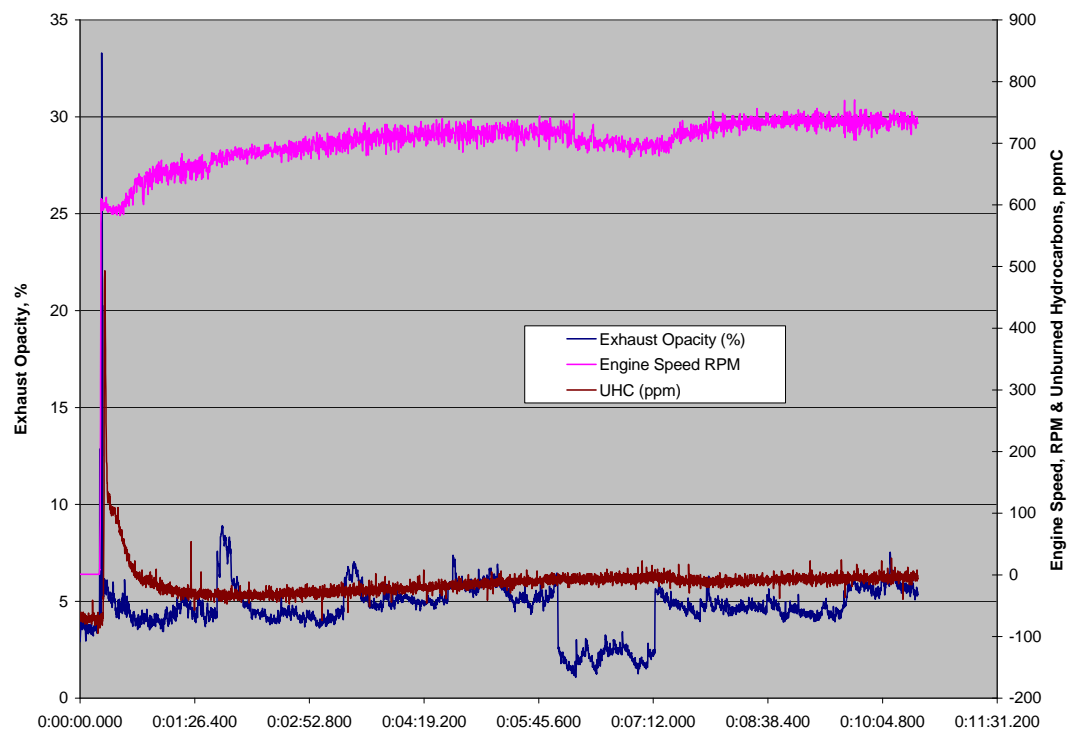


Figure III-8. Temperature Histories during Cranking without Glow Plugs with JP-8 at -25°C

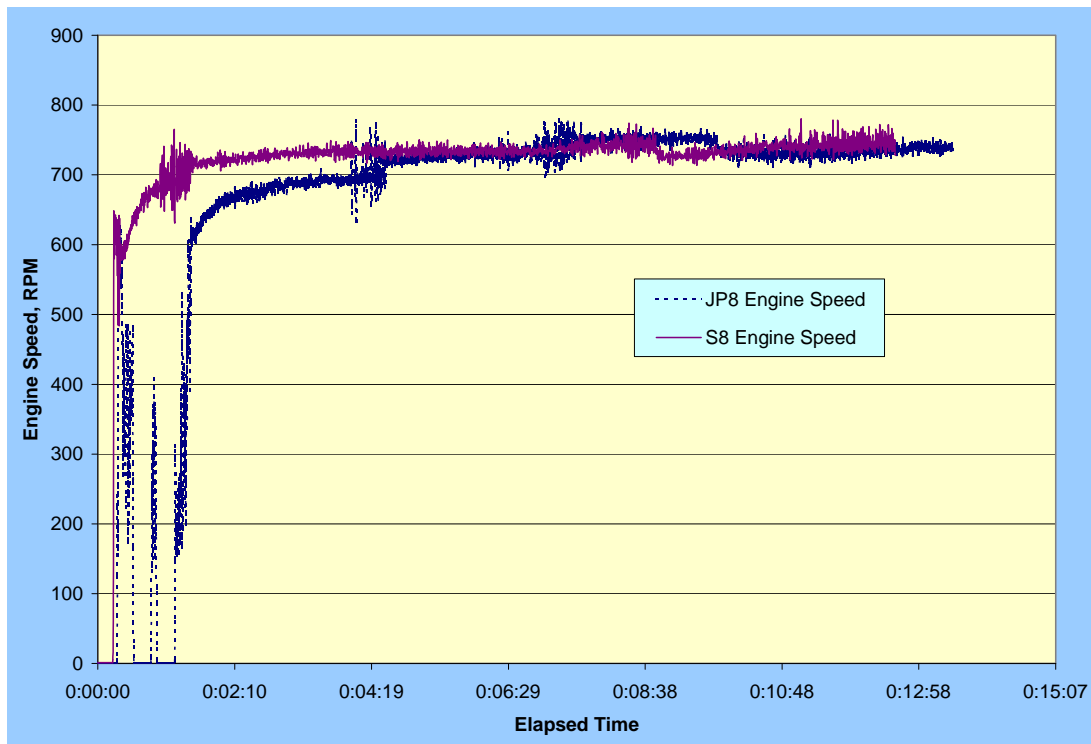


**Figure III-9. JP-8 Fuel Cold Start Exhaust Parameters**



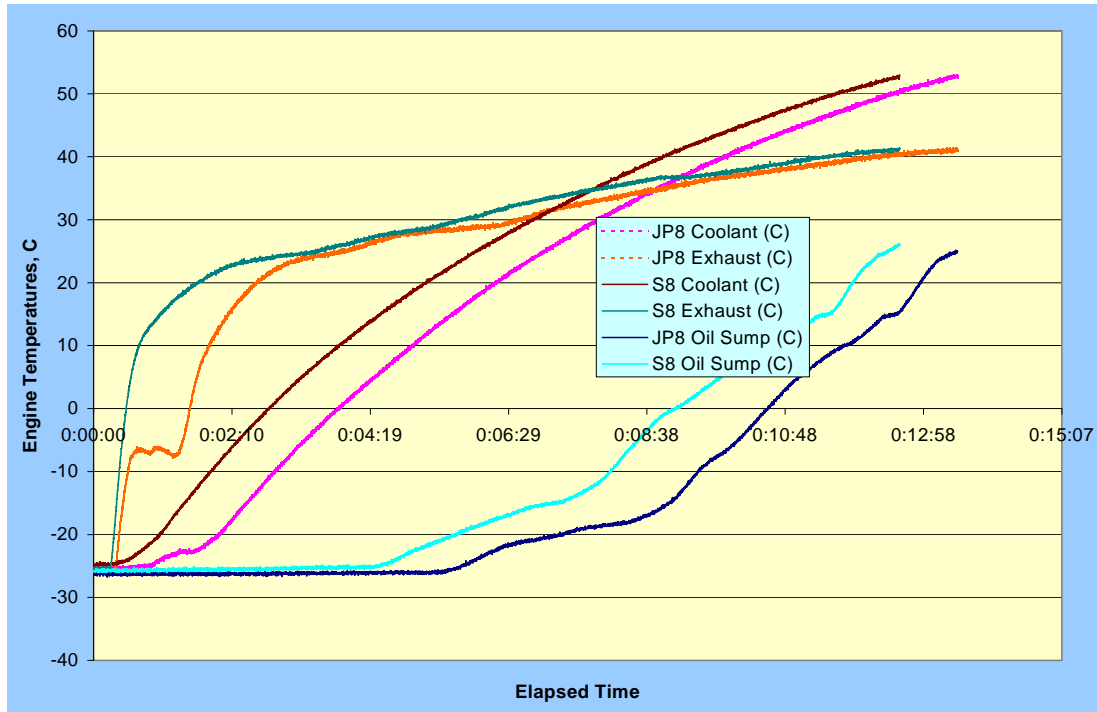
**Figure III-10. S-8 Cold Start Exhaust Parameters**

Initial trials with the second test engine revealed some misfiring at cold temperatures during warm-up. The cold box was set at 10°C and the engine was allowed to warm up to a coolant temperature of 90°C. The injection timing at 1300-RPM and idle speed were checked and set to the appropriate values.



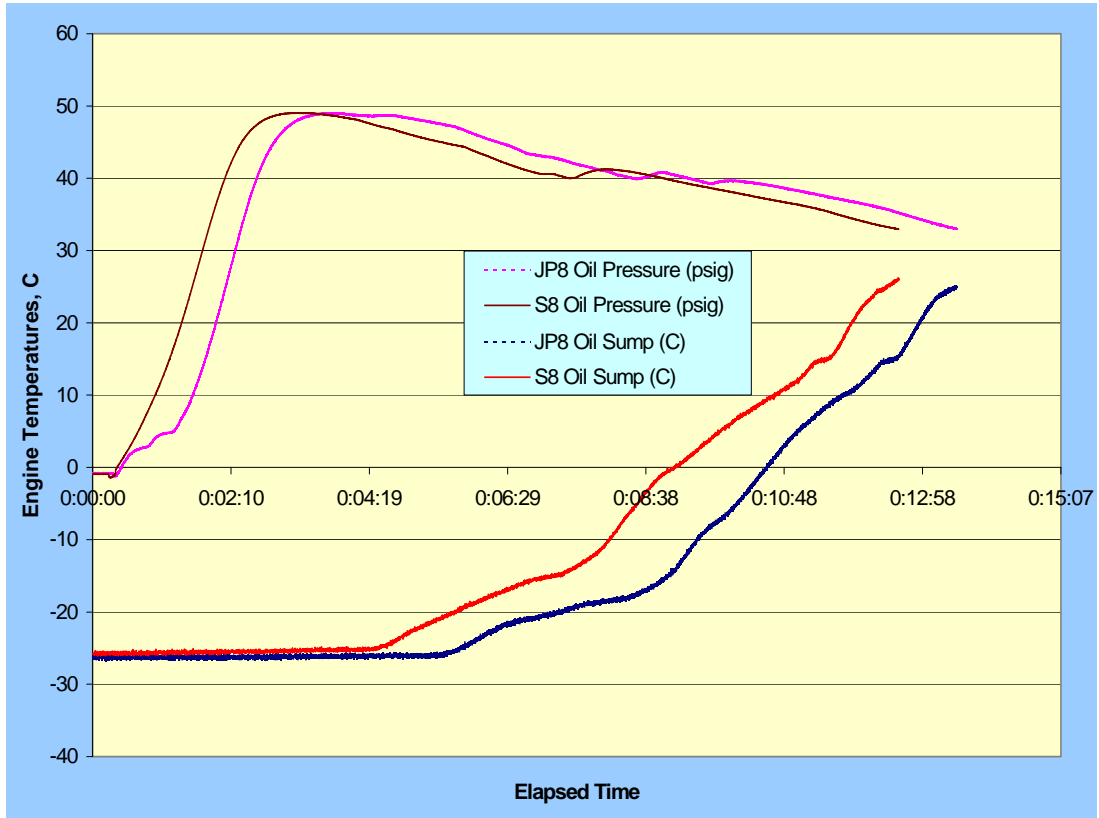
**Figure III-11. Engine Speed for JP-8 and S-8 Cold Start Attempts at -25°C**

Trials were performed with the cold box achieving a -25°C coolant temperature for JP-8 and S-8 fuels. Figure III-11 shows the engine speed during the cold start tests. The S-8 fuel started in about 1-second, whilst the JP-8 tried to start, but would die when the cranking motor shut down. Both fuels show some misfire events after starting, evidenced by large variations in engine speed. The drop in engine speed towards the tail end of the run is when the cold start advance and fast idle solenoids are deactivated, which occurs around 38°C-coolant temperature.



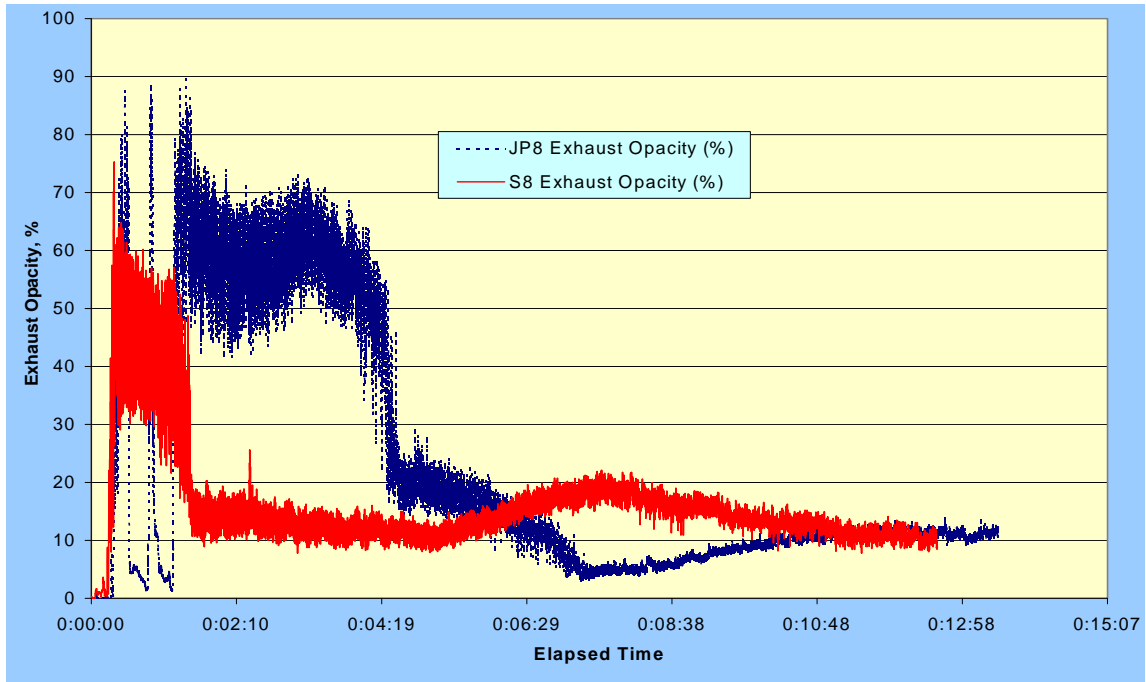
**Figure III-12. JP-8 and S-8 Cold Start Temperature Profiles at -25°C**

The coolant, exhaust, and oil sump temperatures are shown for the JP-8 and S-8 cold start evaluations in Figure III-12. The temperature profiles for JP-8 lag the S-8 profiles by the extended cranking duration for starting. Figure III-13 then shows the oil sump temperature and oil gallery pressure histories during the start attempts. The time to develop an oil pressure that is greater than 20 psig is related to when the engine reaches a stable idle speed.

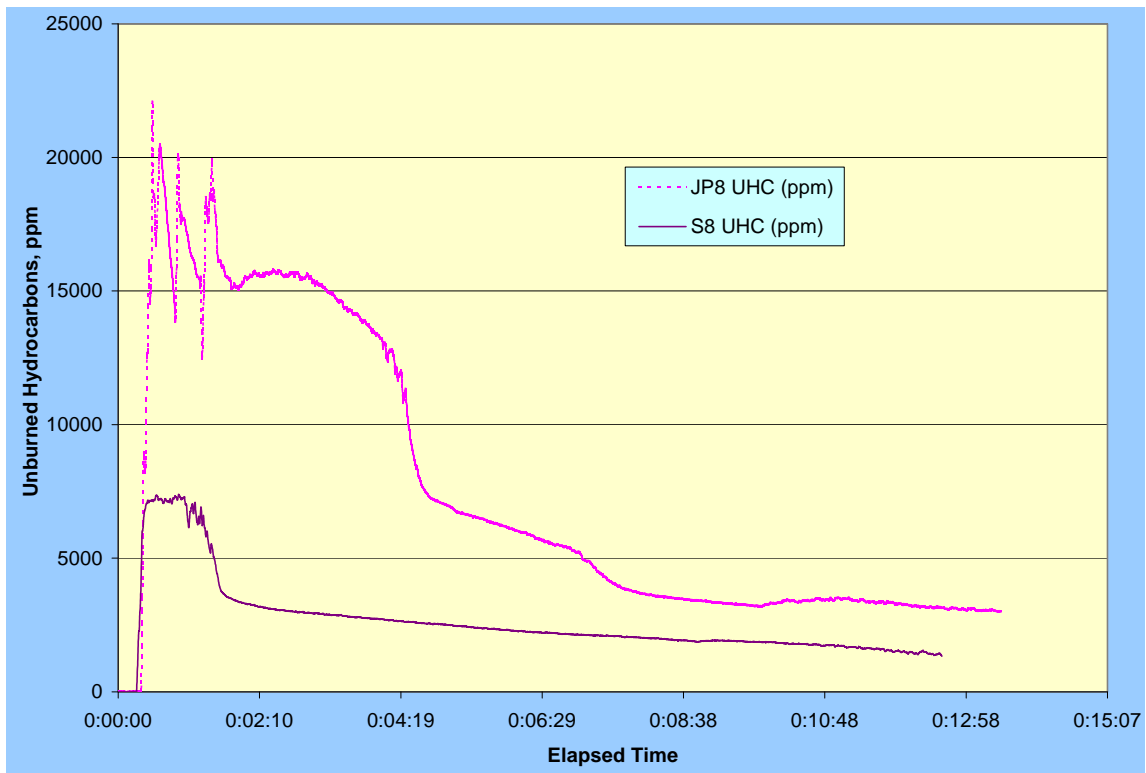


**Figure III-13. Oil Gallery Pressure and Sump Temperature for JP-8 and S-8 Start Attempts**

The Exhaust Opacity and Unburned Hydrocarbons for the cold start evaluations are shown in Figures III-14 and III-15 respectively. During the initial start a cloud of soot is emitted which quickly dissipates to white smoke. The soot cloud is likely due to fuel igniting in the vicinity of the hot glow plugs, and the initial exhaust opacity spike of Figure III-14 represents it. The relative duration of white smoke generation is significantly shorter for the S-8 fuel, as is the magnitude of the exhaust opacity. The unburned hydrocarbon traces in Figure III-15 show dramatically less raw fuel in the exhaust from the S-8 fuel. The -25°C temperature represents the cold limit of the cold box hardware.



**Figure III-14. Exhaust Opacity for JP-8 and S-8 Start Attempts**



**Figure III-15. Unburned Hydrocarbons from JP-8 and S-8 Cold Start Attempts**

Trials were performed to determine the S-8 fuel effects on starting performance with the cold start aids turned off.

The test sequence initially proposed to look at aided cold starts at two attainable temperatures on S-8, JP-8, S-8/JP-8 blend, and DF2. Because of the availability of only high cloud point diesel fuel locally, it was not prudent to try start attempts with DF2. Because all military systems have cold start systems, it is felt that the various fuels performance using the starting aids would provide more useful data for comparisons. Multiple tests were performed using JP-8, S-8, and a 50/50 JP-8/S-8 blend at temperatures of -25°C and -20°C since the cold box would not reliably attain any colder temperatures. The start data sets were performed using the cranking system so that the variability of cranking speed did not influence fuel cold start performance.

The test stand was converted to a battery starter system to determine startability on each fuel at -25°C and -20°C temperature on battery power and using the cold start aids. Efforts were made to keep the battery state of charge as consistent as possible for each start attempt with each fuel. The battery cranking system was tested and worked with the data acquisition and control system.

It was at this stage of the project that the evaporator coils of the cold box became covered in ice. It was anticipated the frozen coils were due to a refrigerant leak; however the failure was traced to a compressor problem. The failure of the cold box would require a complete refitting of the two-stage refrigerant system. The system is no longer in production and the parts were not available. The effort to rebuild the cold box was beyond the scope of the project. However, a secondary chiller system had previously been installed in the cold box and could maintain temperatures around 0°C. Tests with cold start aids disabled and the following three fuels were evaluated to determine cranking time to start at 0°C: S-8, S-8/JP-8 at 50/50, and JP-8.

The initial runs with the S-8 indicated the engine would start around 3°C without glow plugs. Repeat measurements taken on S-8 indicate a start around 3°C without the use of glow plugs reliably. The S-8/JP-8 at 50/50 would not start at 3°C, would not start around 6°C, but would start reliably around 10°C without glow plugs starting aids. It was noted that when the S-8/JP-8 fuel tried to start at 6°C, such that the engine speed went over 300-RPM, a trigger point for the start controller to disengage the starter was reached. At



that time the engine could not sustain combustion and it would stop. When the start threshold speed was raised to 500-RPM the S-8/JP-8 started at 6°C. The neat JP-8 would not start at all around 3°C, but would start reliably at 10°C. The neat JP-8 showed the similar response to the 300-RPM cranking threshold as the S-8/JP-8. But when the start threshold was raised to 500-RPM for neat JP-8, the engine still would not start and sustain with neat JP-8 at 6°C. A reliable start was considered starting three separate times, within 5 intervals of twenty seconds of cranking followed by a 20 second delay.

## **6.0 DISCUSSION OF RESULTS**

A summary of the test fuel cold start performance is included as Tables III-1, III-2, and III-3. The table includes which starting system was utilized; cranking motor or battery and starter, and when the glow plugs cold start aids were used. Included in the Tables is the Start Time, taken as cranking initiation to attaining an engine speed of 600-RPM. Time to coolant temperatures of 35°C and 54°C are also included. The 35°C temperature is where the fast-idle and cold start advance disengages. The 54°C temperature is where the glow plugs controller is inactive. The Opacity and Unburned Hydrocarbons data are calculated for summarization over the engine operating interval.

**Table III-1. S-8 Test Fuel Cold Start Performance in 6.5L Engine**

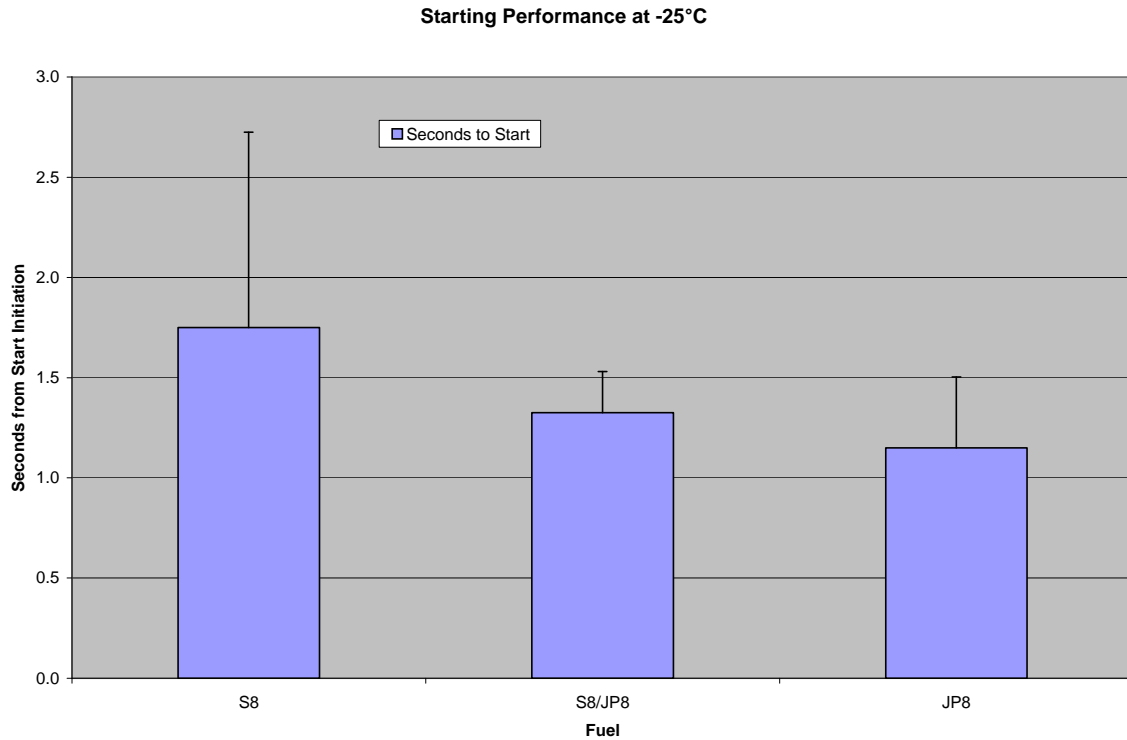
<b>Fuel</b>	<b>Cold Start Aids</b>	<b>Cranking System</b>	<b>Start Attempts</b>	<b>Coolant, °C</b>	<b>Start Time, seconds</b>	<b>35°C Coolant, seconds</b>	<b>54°C Coolant, seconds</b>	<b>Opacity Average, %</b>	<b>Opacity Max, %</b>	<b>Opacity Std. Dev., %</b>	<b>UHC Average, ppmC</b>	<b>UHC Max, ppmC</b>	<b>UHC Std. Dev., ppmC</b>
<b>Cold Start Attempts with RUN Threshold at 300-RPM</b>													
<b>Cold Start Summary with S-8 Fuel</b>													
S-8	Y	M*	1	-26	3.2	456.7	719.9	18.2	77.6	5.7	1884	7915	1371
S-8	Y	M	1	-25	1.1	456.0	741.2	17.6	76.6	9.3	3057	7780	1423
S-8	Y	M	1	-25	1.3	441.3	715.8	18.2	77.2	12.0	2827	6844	1068
S-8	Y	M	1	-25	1.4	449.7	730.6	19.3	82.1	12.4	2946	7363	1355
Average				-25	1.8	450.9	726.9	18.3	78.4	9.9	2679	7476	1304
Standard Deviation				1	1.0	7.1	11.4	0.7	2.5	3.1	538	482	160
S-8	Y	M	1	-19	0.8	396.0	625.3	13.3	72.2	5.8	2321	4214	402
S-8	Y	M	1	-19	1.2	385.6	608.9	8.1	71.9	8.6	2330	4412	488
Average				-19	1.0	390.8	617.1	10.7	72.1	7.2	2326	4313	445
Standard Deviation				0	0.3	7.4	11.6	3.7	0.2	2.0	6	140	61
S-8	N	B/S**	1	3	15.6	264.4	482.5	18.0	99.8	18.0	1709	27682	2949
S-8	N	B/S	2	3	34.9	279.8	490.3	17.7	99.8	23.6	2911	36047	5116
S-8	N	B/S	2	2	58	307.4	512.8	19.3	100.0	27.3	4180	40901	6842
S-8	N	B/S	2	4	49.9	302.2	511.2	9.6	99.4	21.9	3806	25635	6312
Average				3	39.6	288.5	499.2	16.2	99.8	22.7	3152	32566	5305
Standard Deviation				1	18.6	20.0	15.1	4.4	0.3	3.9	1099	7153	1728
<b>Cold Start with Starting Aids and Battery/Starter System</b>													
S-8	Y	B/S	1	4	0.7	254.0	456.0	11.5	36.9	10.0	984	1956	642
*M is constant-speed motor cranking system at 100-RPM													
**B/S is a battery and starter cranking system													

**Table III-2. JP-8 Test Fuel Cold Start Performance in 6.5L Engine**

<b>Fuel</b>	<b>Cold Start Aids</b>	<b>Cranking System</b>	<b>Start Attempts</b>	<b>Coolant, °C</b>	<b>Start Time, seconds</b>	<b>35°C Coolant, seconds</b>	<b>54°C Coolant, seconds</b>	<b>Opacity Average, %</b>	<b>Opacity Max, %</b>	<b>Opacity Std. Dev., %</b>	<b>UHC Average, ppmC</b>	<b>UHC Max, ppmC</b>	<b>UHC Std. Dev., ppmC</b>
<b>Cold Start Summary with JP-8 Fuel</b>													
JP-8	Y	M	4	-25	1.4	549.9	803.0	19.0	90.8	20.7	6985	16796	3830
JP-8	Y	M	1	-25	0.9	436.4	702.4	12.1	62.2	10.8	4640	7075	1399
Average				-25	1.2	493.2	752.7	15.6	76.5	15.8	5813	11936	2615
Standard Deviation				0	0.4	80.3	71.1	4.9	20.2	7.0	1658	6874	1719
JP-8	Y	M	1	-19	1.1	412.7	655.8	14.5	81.7	21.3	5341	11471	2661
JP-8	Y	M	1	-19	1.0	418.3	667.0	21.5	89.0	23.6	5381	11054	2665
Average				-19	1.1	415.5	661.4	18.0	85.4	22.5	5361	11263	2663
Standard Deviation				0	0.1	4.0	7.9	4.9	5.2	1.6	28	295	3
JP-8	N	B/S	5	6	NS	NS	NS	41.9	100.0	38.5	27615	38139	7458
JP-8	N	B/S	5	5	NS	NS	NS	47.0	100.0	42.5	26211	31161	5426
JP-8	N	B/S	5	6	NS	NS	NS	53.6	99.8	38.6	29158	36760	6722
Average				6				47.5	99.9	39.9	27661	35353	6535
Standard Deviation				1				5.9	0.1	2.3	1474	3696	1029
JP-8	N	B/S	5	3	NS	NS	NS	53.1	98.6	38.3	24481	31456	8189
JP-8	N	B/S	5	3	NS	NS	NS	66.9	99.2	33.9	26096	36824	5331
JP-8	N	B/S	5	3	NS	NS	NS	58.1	98.9	38.2	25767	30334	5384
Average				3				59.4	98.9	36.8	25448	32871	6301
Standard Deviation				0				7.0	0.3	2.5	853	3469	1635

**Table III-3. 50%S-8 / 50% JP-8 Test Fuel Cold Start Performance in 6.5L Engine**

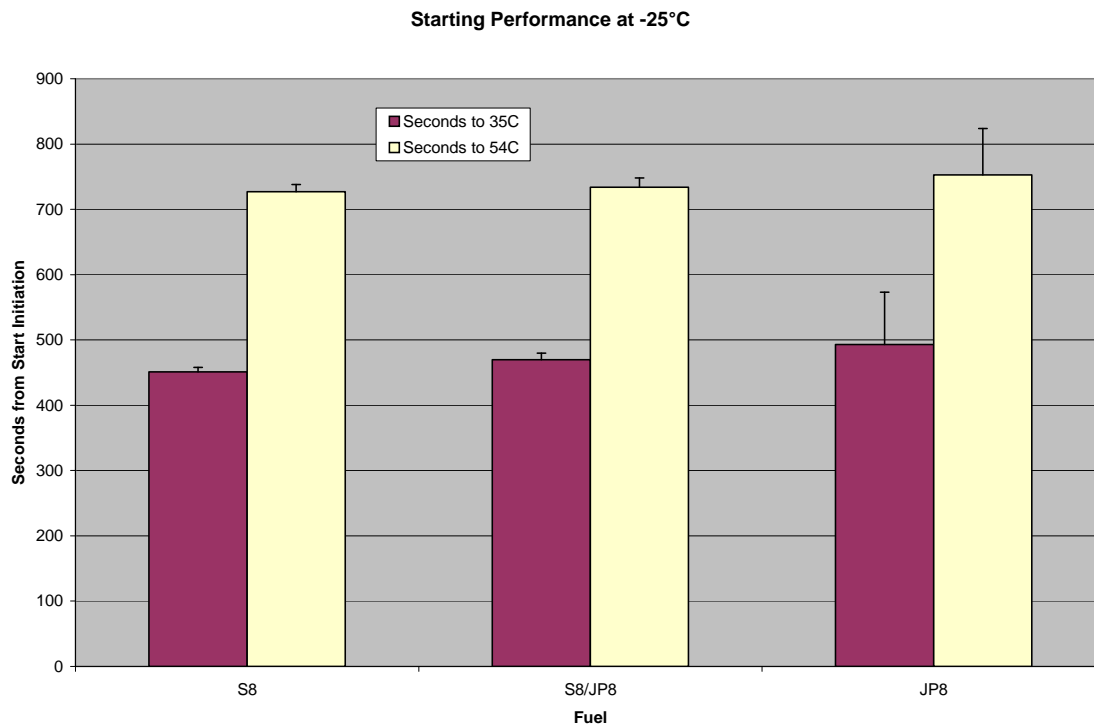
Fuel	Cold Start Aids	Cranking System	Start Attempts	Coolant, °C	Start Time, seconds	35°C Coolant, seconds	54°C Coolant, seconds	Opacity Average, %	Opacity Max, %	Opacity Std. Dev., %	UHC Average, ppmC	UHC Max, ppmC	UHC Std. Dev., ppmC
<b>Cold Start Summary with 50-percent S-8 and 50-percent JP-8 Blend</b>													
S-8/JP-8	Y	M	1	-26	1.3	475.0	745.5	25.7	96.6	24.7	4870	11903	2647
S-8/JP-8	Y	M	1	-26	1.3	464.4	721.9	26.3	92.2	24.3	5100	11985	2740
S-8/JP-8	Y	M	1	-26	1.6	458.7	721.0	18.9	87.4	18.7	3760	7578	1592
S-8/JP-8	Y	M	2	-26	1.1	480.9	747.0	26.2	90.8	25.9	5370	12826	2865
Average				-26	1.3	469.8	733.9	24.3	91.8	23.4	4775	11073	2461
Standard Deviation				0	0.2	10.0	14.3	3.6	3.8	3.2	707	2367	586
S-8/JP-8	Y	M	1	-20	1.1	408.3	658.6	14.8	85.9	10.9	2920	6031	782
S-8/JP-8	Y	M	1	-20	1.3	402.0	660.5	16.1	89.5	14.3	3343	5568	939
Average				-20	1.2	405.2	659.6	15.5	87.7	12.6	3132	5800	861
Standard Deviation				0	0.1	4.5	1.3	0.9	2.5	2.4	299	327	111
S-8/JP-8	N	B/S	6	3	286.4	NA	NA	73.5	99.8	30.1	27076	48624	6646
S-8/JP-8	N	B/S	5	3	NS	NS	NS	71.9	99.9	31.0	28214	48624	6496
S-8/JP-8	N	B/S	5	3	NS	NS	NS	55.4	98.0	40.1	25687	28803	3245
S-8/JP-8	N	B/S	5	3	NS	NS	NS	52.2	98.0	40.0	24669	28166	4616
Average				3	286.4			63.3	98.9	35.3	26412	38554	5251
Standard Deviation				0				11.0	1.1	5.5	1555	11630	1625
S-8/JP-8	N	B/S	5	6	NS	NS	NS	53.1	100.0	41.6	27799	38698	7950
S-8/JP-8	N	B/S	5	5	NS	NS	NS	50.8	99.1	45.4	25986	48624	7567
S-8/JP-8	N	B/S	5	5	NS	NS	NS	52.2	99.2	42.0	26515	35605	6717
Average				5				52.0	99.4	43.0	26767	40976	7411
Standard Deviation				1				1.2	0.5	2.1	932	6802	631
<b>Cold Start Attempts with RUN threshold at 500-RPM</b>													
S-8/JP-8	N	B/S	2	5	52.4	NA	NA	NA	NA	NA	NA	NA	NA
JP-8	N	B/S	5	5	NS	NS	NS	NA	NA	NA	NA	NA	NA



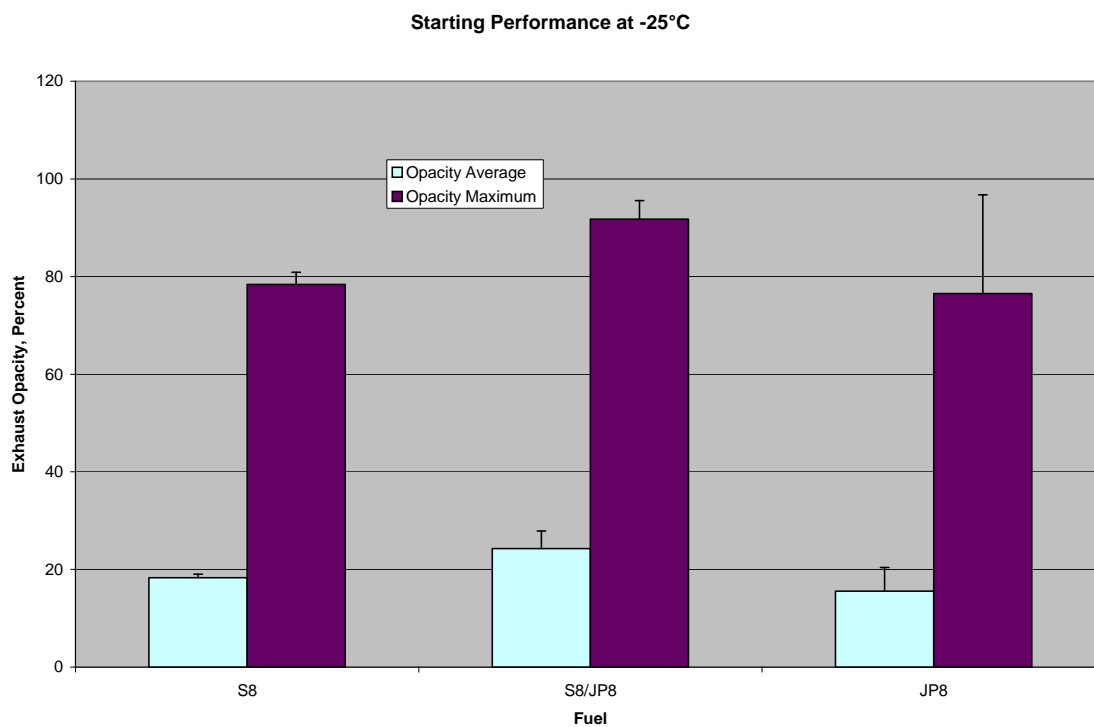
**Figure III-16. Start Time at -25°C with Starting Aids and Cranking Motor**

Figures III-16 through III-29 represents data from Tables III-1 through III-3. Figure III-16 is the seconds to start for each test fuel at -25°C, when the cranking motor and glow plugs are utilized. The start time was taken as the time from crank initiation to the first time the engine speed reached 600-RPM not the time to a stabilized 600-RPM engine speed. One run with neat S-8 had a long crank time that affected the average, but the other S-8 runs were consistent with the other fuels. The data suggest due to the similar volatility of each fuel, the time to start is impacted by the glow plugs considerably because the cetane difference between fuels is not evident.

Figure III-17 reveals a slight improvement in warm up time with the S-8 fuel blends. This is likely due to a more stable idle that can be partially attributed to cetane number. The decrease in warm up time is small compared to the overall time to warm up the engine. However in an actual vehicle the engine load would likely be higher and that would impact warm up time greatly.

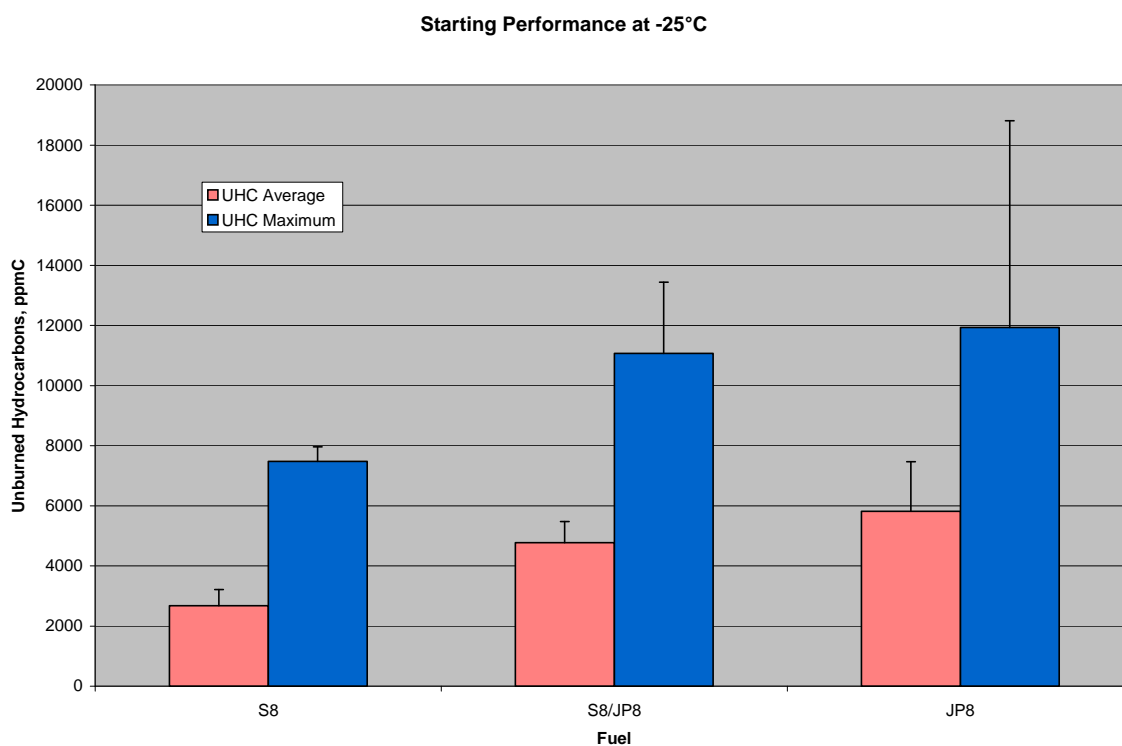


**Figure III-17. Warm Up Time at -25°C with Starting Aids and Cranking Motor**



**Figure III-18. Exhaust Opacity at -25°C with Starting Aids and Cranking Motor**

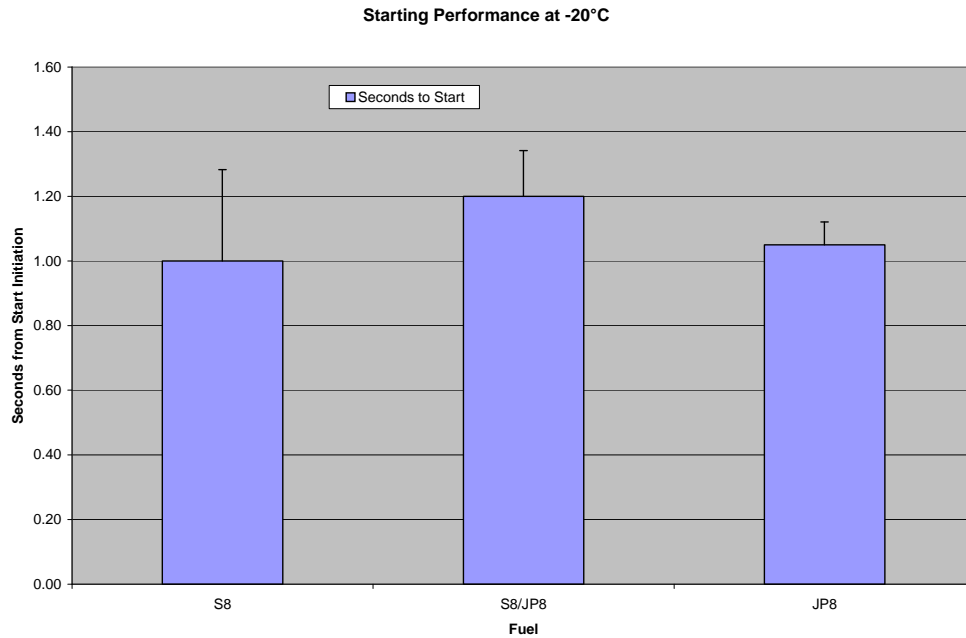
The Exhaust Opacity data in Figure III-18 at -25°C suggests there is a similar amount of white smoke for each test fuel. The white smoke can be affected by volatility and to a small degree by viscosity.



**Figure III-19. Exhaust Unburned Hydrocarbons at -25°C with Starting Aids and Cranking Motor**

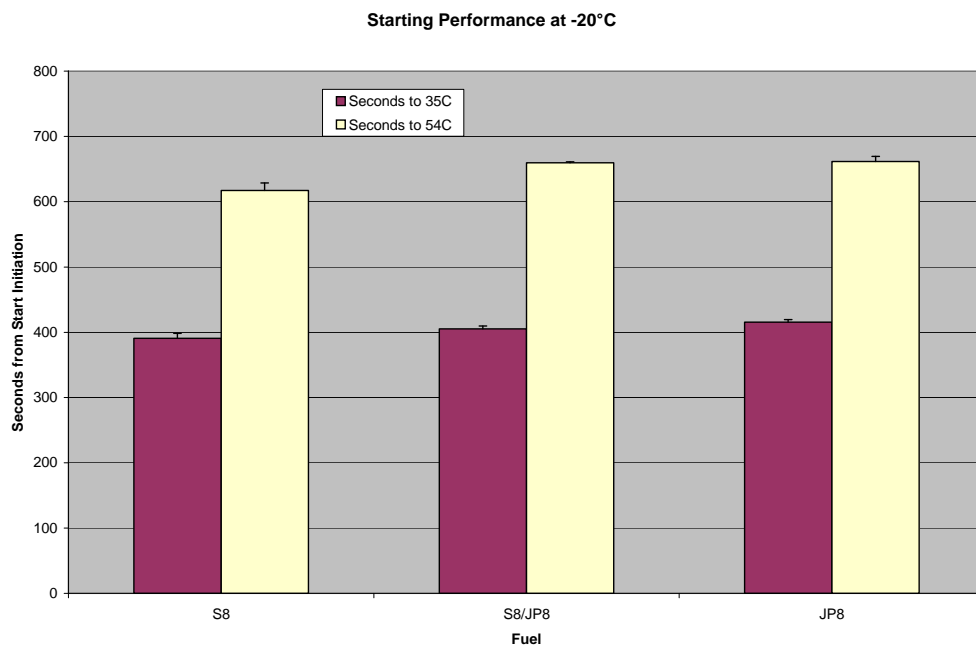
The largest variation between test fuels at -25°C is seen in Figure III-19 for the Unburned Hydrocarbons (UHC) in the exhaust. Both the average and maximum UHC are lower with increasing S-8 content in the fuel.

Figure III-20 is the seconds to start for each test fuel at -20°C, when the cranking motor and glow plugs are utilized. The start time was taken as the time from crank initiation to the first time the engine speed reached 600-RPM. The data suggest due to the similar volatility of each fuel, the time to start is impacted by the glow plugs considerably. In the 6.5L engine the fuel spray is in very close proximity of the glow plugs in each cylinder. The cetane number difference between fuels is not evident in the start times.



**Figure III-20. Start Time at -20°C with Starting Aids and Cranking Motor**

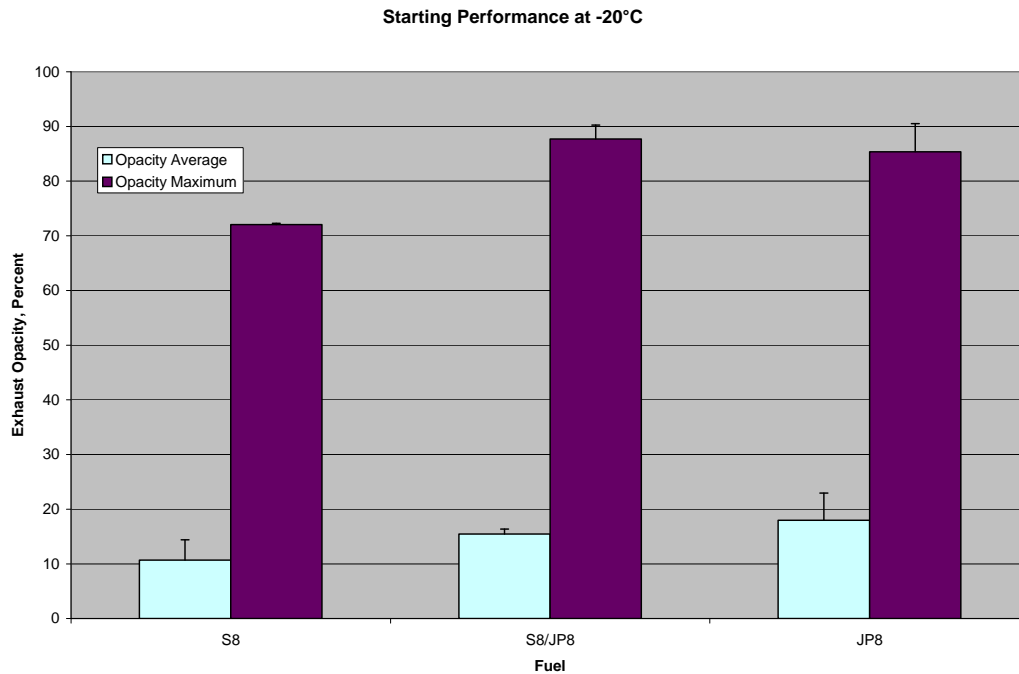
Figure III-21 reveals a slight improvement in warm up time with the S-8 fuel blends at -20°C. This is likely due to a more stable idle that can be partially attributed to cetane number. The decrease in warm up time at -20°C is small compared to the overall time to warm up the engine.



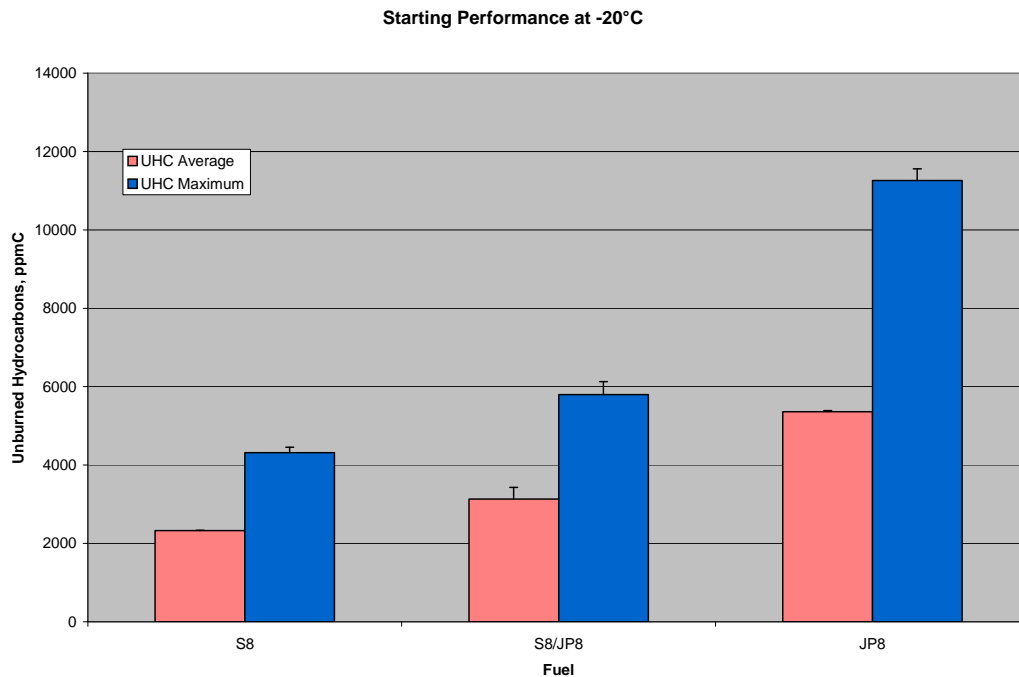
**Figure III-21. Warm Up Time at -20°C with Starting Aids and Cranking Motor**



From Figure III-22 the effects of S-8 content on exhaust opacity at -20°C is more evident than that seen at -25°C. Both the average and maximum exhaust opacity due to white smoke are reduced with S-8 fuel content

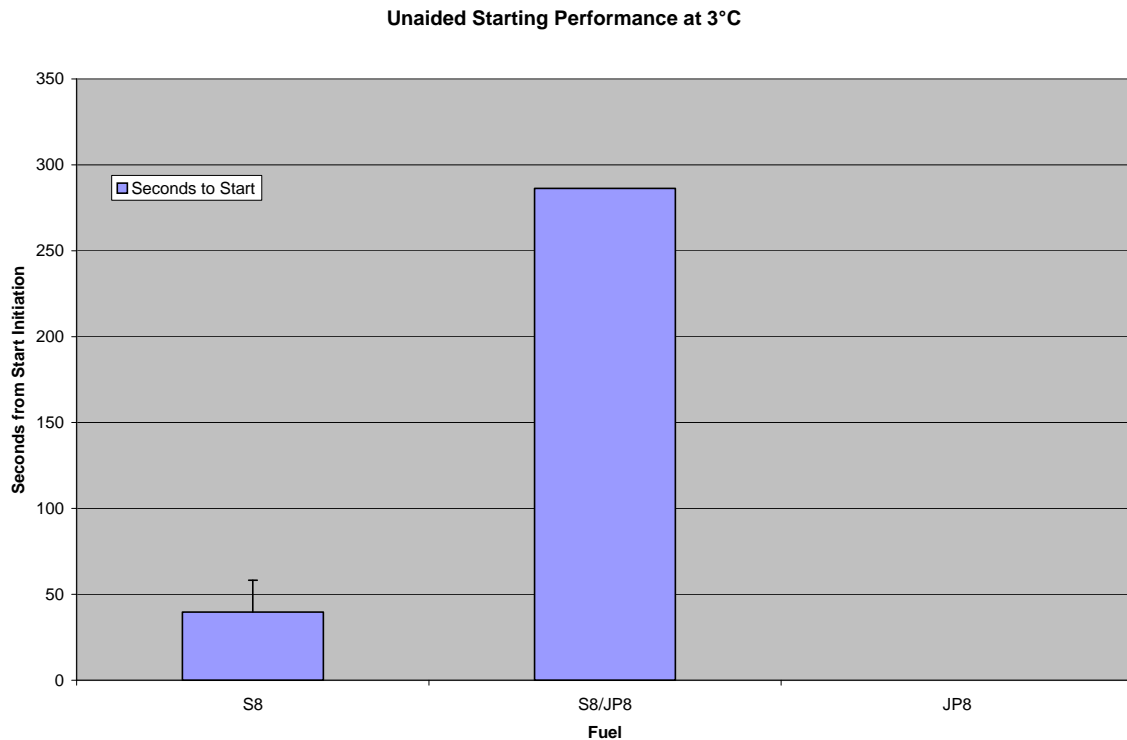


**Figure III-22. Exhaust Opacity at -20°C with Starting Aids and Cranking Motor**



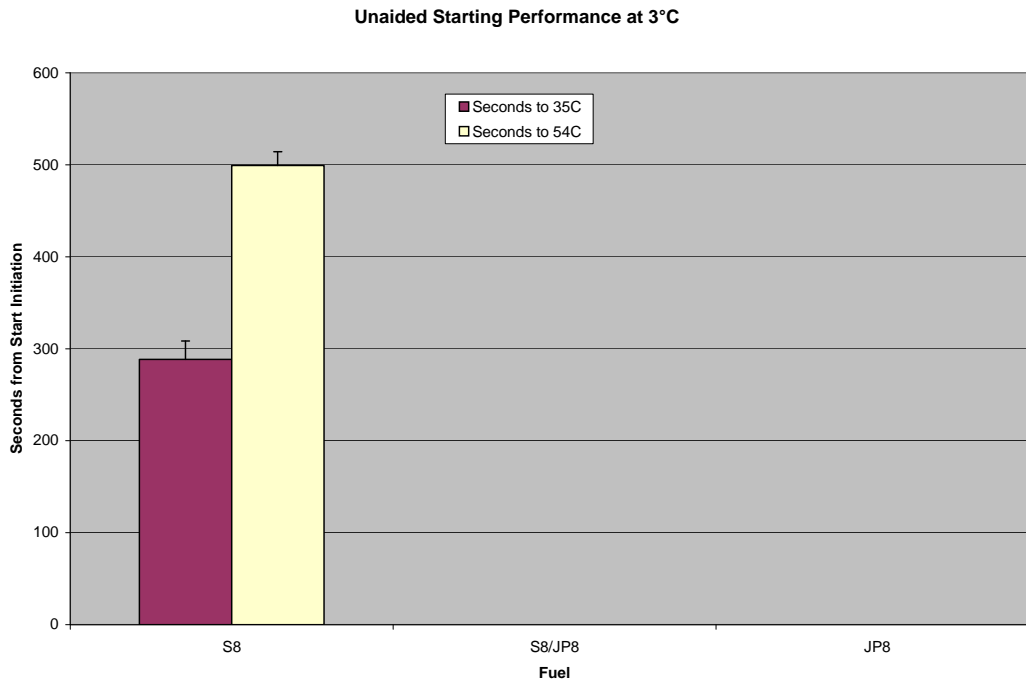
**Figure III-23. Exhaust Unburned Hydrocarbons at -20°C with Starting Aids and Cranking Motor**

From Figure III-23 a trend of decreasing exhaust UHC emissions is seen with increased S-8 fuel content. The results from the exhaust opacity measurements suggest this should be the case. When cold starting aids are utilized, it is apparent there is less UHC in the exhaust at cold temperatures with S-8.



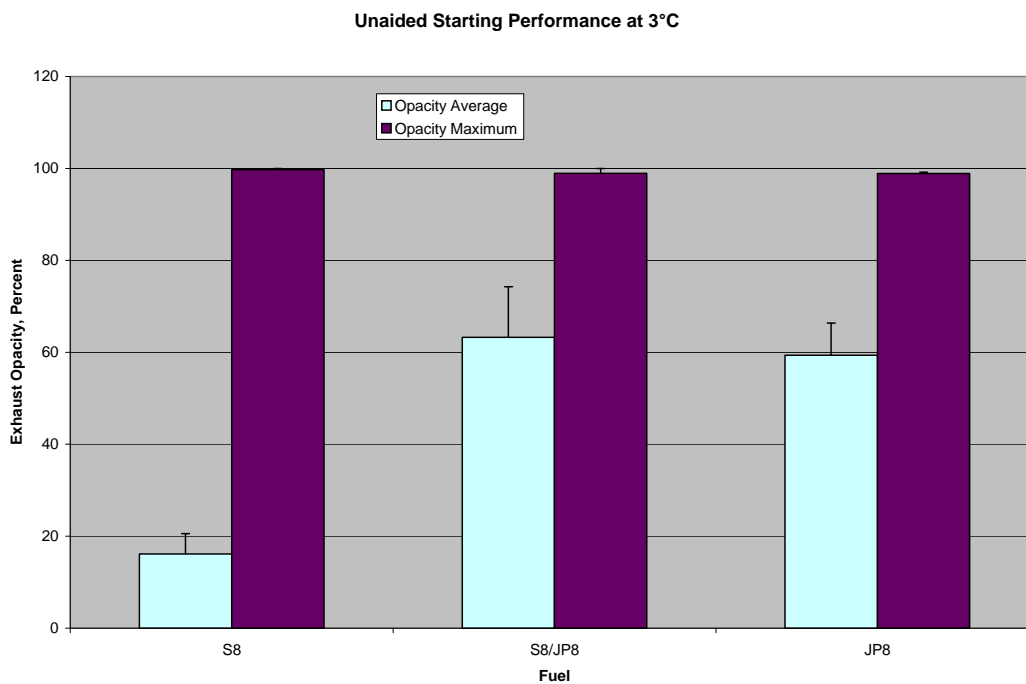
**Figure III-24. Start Time at 3°C without Starting Aids and with Battery/Starter**

Start times when the engine is cranked with the battery and starter, with glow plugs disabled is shown in Figure III-24 for 3°C. The engine would not start on JP-8 at 3°C without glow plugs. The engine did start with the S-8/JP-8 blend after a sixth crank attempt. The engine would attempt to run during the previous five attempts but never sustain.



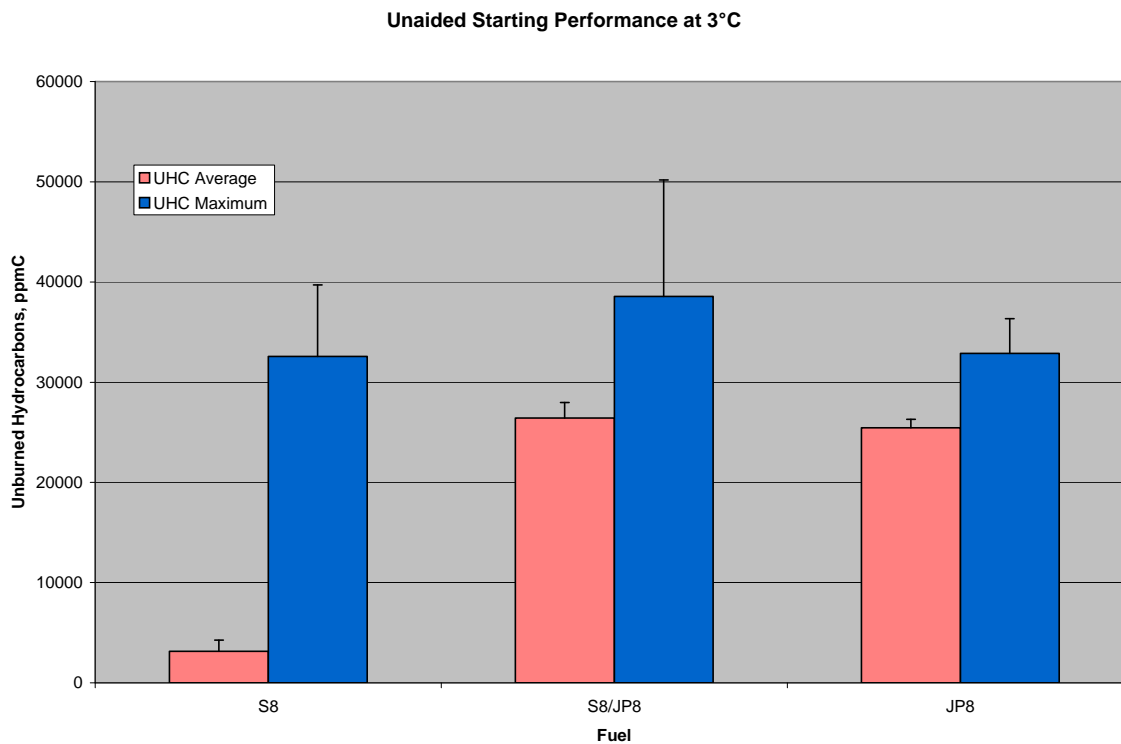
**Figure III-25. Warm Up Time at 3°C without Starting Aids and with Battery/Starter**

Although the engine did start on the S-8/JP-8 blend at 3°C, the warm up data was not collected due to the control system shutting down the engine. The warm up time for S-8 in Figure III-25 appears proportional to the test temperature.



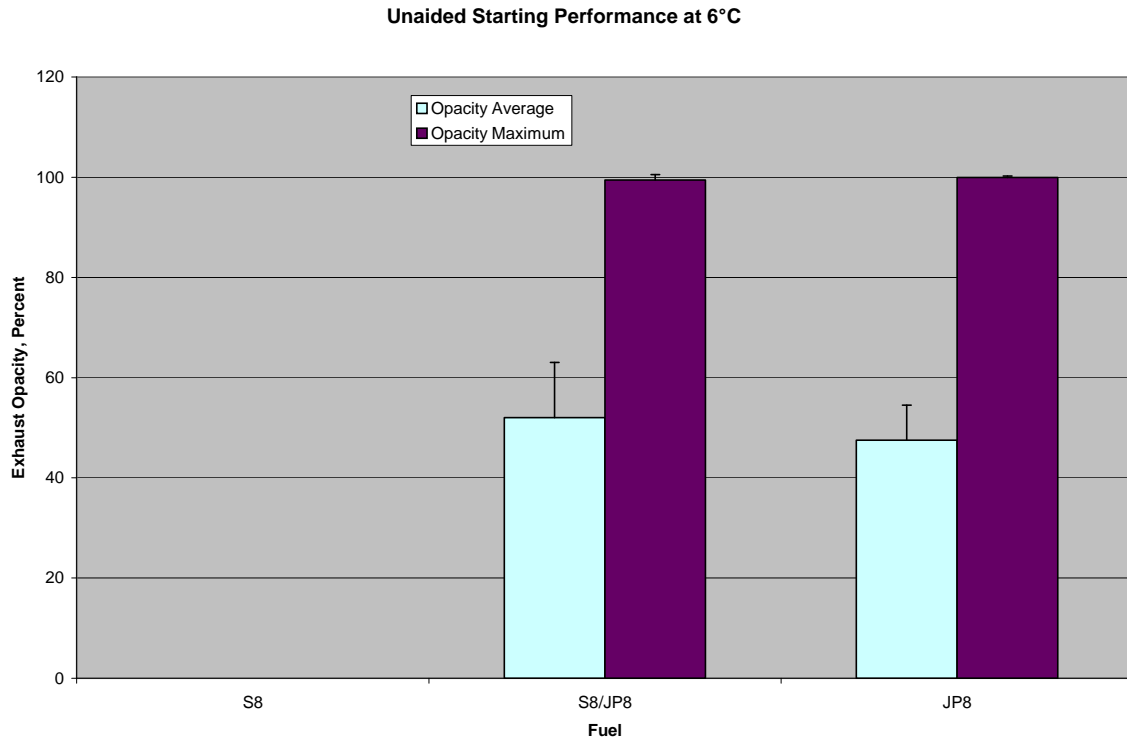
**Figure III-26. Exhaust Opacity at 3°C without Starting Aids and with Battery/Starter**

Figure III-26 suggests that during cold starting without glow plugs there are substantial maximum levels of white smoke, regardless of fuel type. However, the S-8 fuel has a reduced average exhaust opacity due to the engine starting at 3°C without glow plugs.



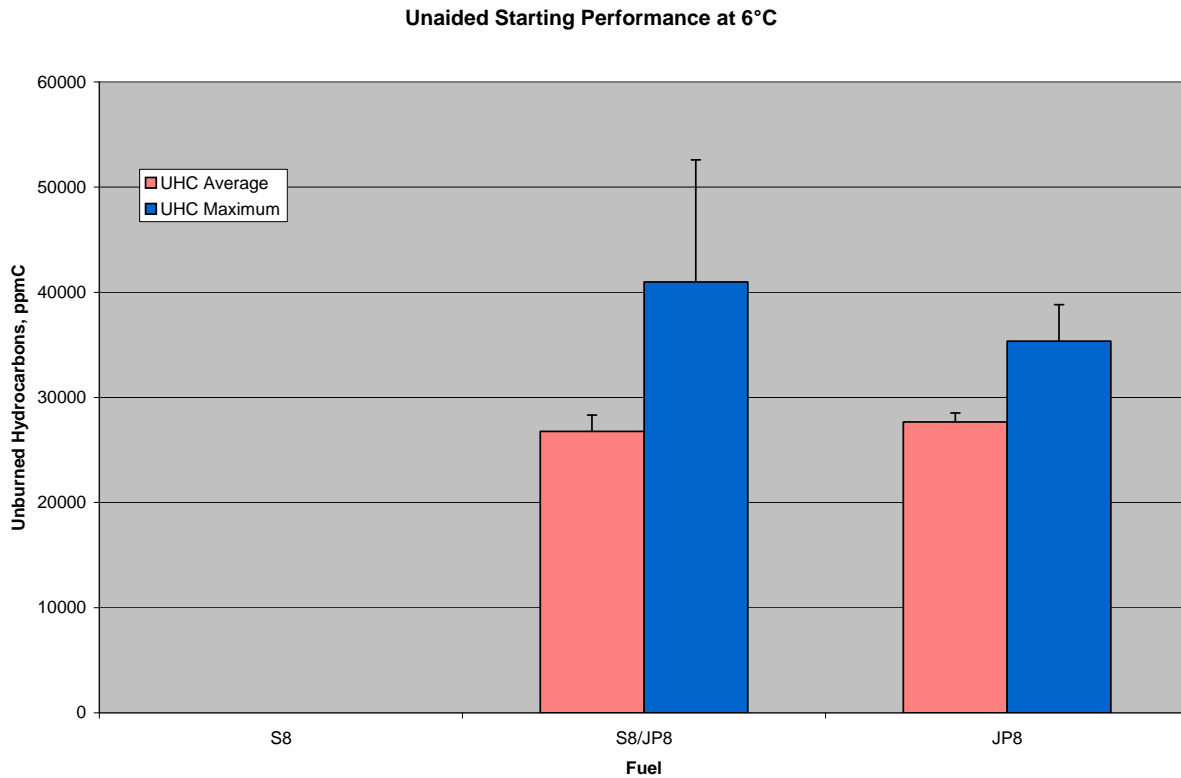
**Figure III-27. Exhaust Unburned Hydrocarbons at 3°C without Starting Aids and with Battery/Starter**

Figure III-27 suggests that during cold starting without glow plugs there are substantial maximum levels of unburned hydrocarbons, regardless of fuel type. Corresponding to the exhaust opacity result, the S-8 fuel also has reduced average unburned hydrocarbons due to the engine starting at 3°C without the use of glow plugs.



**Figure III-28. Exhaust Opacity at 6°C without Starting Aids and with Battery/Starter**

Cold start tests were not performed with the neat S-8 fuel at 6°C, but evaluations were performed with neat JP-8 and the S-8/JP-8 blend. Figure III-28 suggests that during cold starting without glow plugs there are substantial maximum and average levels of white smoke, regardless of fuel type, when the engine does not start. It should be noted the S-8/JP-8 blend attempted to start but would not sustain engine operation at 6°C with a 300-RPM start threshold. A brief trial with a 500-RPM start threshold resulted in a start with S-8/JP-8 blend.



**Figure III-29. Exhaust Unburned Hydrocarbons at 6°C without Starting Aids and with Battery/Starter**

Figure III-29 suggests that during cold starting without glow plugs there are substantial maximum and average levels of unburned hydrocarbons in the exhaust, regardless of fuel type, when the engine does not start.

## 7.0 SUMMARY AND CONCLUSIONS

Based on the limitations of test hardware for attaining absolute start temperature thresholds, the following conclusions can be made for the S-8, S-8/JP-8, and JP-8 fuels in the General Engine Products 6.5L, naturally -aspirated, IDI, diesel engine:

- With a constant speed cranking motor at 100-RPM and glow plugs utilization the data suggest due to the similar volatility of each fuel, the time to start is impacted by the glow plugs considerably. In the 6.5L engine the fuel spray is in very close proximity of the glow plugs in each cylinder. The cetane number difference between fuels is not evident in the start times.
- There is a slight improvement in engine warm up time with S-8 content in the fuel blends. This is likely due to a more stable idle that can be partially attributed to cetane number. The decrease in warm up time is small compared to the overall time to warm up the engine.
- The Exhaust Opacity data at  $-25^{\circ}\text{C}$  suggests there is a similar amount of white smoke for each test fuel, however at  $-20^{\circ}\text{C}$  both the average and maximum exhaust opacity due to white smoke are reduced with S-8 fuel content.
- The largest variation between test fuels is seen for the Unburned Hydrocarbons (UHC) in the exhaust. Both the average and maximum UHC are lower with increasing S-8 content in the fuel. The results from the exhaust opacity measurements suggest this should be the case. When cold starting aids are utilized, it is apparent there is less UHC in the exhaust at cold temperatures with increasing S-8 content.
- Start times when the engine is cranked with a battery and starter, and glow plugs disabled; indicate the engine will start on S-8 at  $3^{\circ}\text{C}$ . The engine would not start on JP-8 at  $3^{\circ}\text{C}$  without glow plugs. The engine did start with the S-8/JP-8 blend after a sixth crank attempt. The engine would attempt to run during the previous five attempts but never sustain.
- During cold starting without glow plugs there are substantial maximum levels of white smoke, regardless of fuel type. However, the S-8 fuel has a reduced average exhaust opacity due to the engine eventually starting at  $3^{\circ}\text{C}$  without the use of glow plugs.
- When cold starting without glow plugs there are substantial maximum levels of unburned hydrocarbons, regardless of fuel type. Corresponding to the exhaust opacity result, the S-8 fuel also has reduced average unburned hydrocarbons due to the engine starting at  $3^{\circ}\text{C}$  without the use of glow plugs.

- During cold start attempts without glow plugs there are substantial maximum and average levels of white smoke and substantial maximum and average levels of unburned hydrocarbons in the exhaust, regardless of fuel type, when the engine does not start.
- It should be noted the S-8/JP-8 blend attempted to start but would not sustain engine operation at 6°C with a 300-RPM start threshold. A brief trial with a 500-RPM start threshold resulted in a start with S-8/JP-8 blend.

## **8.0 REFERENCES FOR TASK III**

1. Clerc, J.C., "Cetane number requirements of light-duty diesel engines at low temperatures," SAE Paper 861525, 1986.
2. Hara, H., Itoh, Y., Henein, N.A. and Bryzik, W., "Effect of cetane number with and without additive on cold startability and white smoke emissions in a diesel engine," SAE Paper 1999-01-1476, 1999.
3. Henein, N.A., "Cetane scale evaluation and possible modification," ADA189730; ARO-21397.2-EG, August 1987.
4. Cartwright, S.J.; Gilbert, J. B., "Investigation of the low temperature performance of trucks operating on low cetane diesel fuel," SAE Paper 881648, November 1989.
5. Neill, W.S.; Wolf, W.M.; Webster, G.D., "Cold temperature diesel performance/combustion with Canadian low ignition quality fuels," SAE Paper 860263, February 1986.
6. Army TM 9-2815-237-34, Technical Manual, Direct Support and General Support Maintenance, Engine, Diesel: 8 Cylinder, Naturally Aspirated, Fuel-Injected, Water Cooled, January 1996.

## **IV. TASK IV: IDENTIFICATION OF ARMY FUEL INJECTION PUMP ELASTOMERS**

### **1.0 OBJECTIVES**

The objectives of this task were to:

- Identify the elastomeric components (seals, O-rings, gaskets etc.) found in the fuel injection pumps of selected high density combat, wheeled and ground support equipment.
- Identify the engine manufacturer and model numbers of selected equipment.



- Obtain injection pump national stock number and part number from pertinent technical manuals.
- Identify fuel injection pump manufacturers.
- Contact fuel injection pump manufacturers to obtain elastomer composition and schematic drawings showing when available.
- Estimate the potential for injection pump leakage based on composition of elastomers and their location within the pump.

## 2.0. APPROACH

A list of selected equipment was developed using Department of Defense Off-Road Fuel Consuming Mobility Ground Support Equipment Listing compiled by TFLRF. [1] Equipment selection was based on densities and mission criticality of equipment. Technical Manuals were utilized to obtain information on the injection pumps fueling selected equipment. Table IV-1 shows the equipment that meets these criteria:

<b>Table IV-1. High Density and or Mission Critical Equipment</b>			
<b>Equipment Nomenclature</b>	<b>Engine Manufacturer Model Number</b>	<b>Injection Pump Type</b>	<b>Pump Manufacturer</b>
Bradley Fighting Vehicle M2/3	Cummins Engine VTA 903T	Pressure Timed	Cummins Engine
5 Ton M939 Series Truck	Cummins NHC 250	Pressure Timed	Cummins Engine
Recovery Vehicle M88A1/2 Combat Engineer Vehicle M728 Bridge Launcher M60	Continental AVDS 1790 2-DR	Rotary, Cam Operated	AMBAC International
Stryker Light Armored Vehicle	Caterpillar 3126B	Unit Injector	Caterpillar Inc.
Light/Medium Tactical Vehicle	Caterpillar 3116/3126B	Unit Injector	Caterpillar Inc.
HMMWV Series Truck	GM 6.2 / 6.5L	Rotary	Stanadyne
5 Ton M939A2 Series Truck	Cummins 6CTA 8.3L	In-Line Cam Actuated	Bosch

<b>Table IV-1. High Density and or Mission Critical Equipment</b>			
Truck 10 Ton HEMMT	Detroit Diesel 8V92T	Unit Injector	Detroit Diesel
Combat Earthmover DEUCE	Caterpillar 3126 HEUI	Unit Injector	Caterpillar
Container Handler RT240 53K	Cummins QSM 11	Pressure Timed	Cummins
Generator Set 100 kW	Caterpillar D3306(T)	In-Line Cam Actuated	Caterpillar
Generator Set 60 kW	John Deere 6059T Allis Chalmers 3500	Rotary	Stanadyne
Truck Forklift RT 10K	John Deere 6059T	Rotary	Stanadyne

Part numbers and parts schematics showing location of elastomer components were extracted from the manuals (Appendix IV-B) and the FED LOG Interactive Database queried for injection pump manufacturer and national stock numbers. Injection system manufacturers were contacted for identification of elastomer composition. From this effort, a table entitled “Injection Pump Elastomer Identification Table” (Appendix IV-A) was developed. The following information parameters are found in the table:

- Equipment Nomenclature
- Engine Manufacturer and Model Number
- Injection System Manufacturer
- Injection System Type
- Seal/Gasket Nomenclature
- National Stock Number
- Part Number
- Elastomer Composition
- Technical Manual Number

### **3.0 DISCUSSION**

The Injection Pump Elastomer Identification Table in Appendix IV-A is comprised of combat tracked, tactical wheeled, generator sets, material handling, and engineer earth moving equipment. The injection pump manufacturers identified as suppliers of the fueling components for these different vehicles and equipment are Stanadyne Company, Inc., AMBAC (formerly

American Bosch), Detroit Diesel, Bosch, Caterpillar, Delphi Pump Company, and Cummins Engine Company.

The supplier companies were contacted telephonically or by email to request information concerning elastomers and composition in their respective injection pumps. Responses received were at times not all-inclusive and other sources for elastomer composition had to be utilized. Examples of these sources were: PartsBase, a government logistics data provider for the defense industry, FED LOG interactive database. The FED LOG Interactive Database is a logistics information system that allows the retrieval of data from the Federal Logistics Information System (FLIS) and service specific databases. Local diesel injection service companies were also utilized to obtain elastomer information. Cummins Engine Co. was the only supplier company that did not respond and informed TFLRF that without a contractual agreement, proprietary information of the list of elastomers and materials used on the PT pumps could not be divulged.

Elastomers, material and number of times they appear in the elastomer identification table for the different injection pumps identified are shown in Table IV-2. They are further broken down and grouped by material family and shown in Table IV-3.

<b>Table IV-2. Elastomer Materials Identified in ID Table</b>	
<b>Composition Material</b>	<b>Number of Occurrences</b>
Viton	74
Buna N Nitrile	13
Butadiene-Arylonitrile	12
Butyl Rubber	10
Synthetic Rubber	9
Nitrile (Buna)	4
Butadiene	3
HPNP & Nitrile	1
Viton SR	1
Fluorosilicone	1
Buna N Nitrile SR	1
Nylon	1

<b>Table IV-3. Elastomer Materials Identified in ID Table Grouped by Family</b>		
<b>Composition Material</b>	<b>Number of Occurrences</b>	<b>Total %</b>
Viton	75	57
Nitrile	31	24
Butyl Rubber	10	8
Synthetic Rubber	9	7
Butadiene	3	2
Fluorosilicone	1	1
Nylon	1	1

An objective in the identification of elastomers was estimating the potential for injection pump leakage based on composition of elastomers, and their location within the pump. The following is a brief discussion on each of the elastomer compositions identified in the same order as the table above and an assessment on their propensity to react adversely and cause leakage when switched between aromatic and non-aromatic fuels:

The most prominent rubber material found in the survey of injection pump elastomers was Viton. Viton is a synthetic rubber and fluoropolymer elastomer commonly used in O-rings. In previous testing, Viton elastomers were found to exhibit low variances in mass and volume changes when switch loaded between synthetic fuel containing no aromatics and JP-8 fuel with aromatics. Therefore, it can be speculated that Viton elastomers should present minimal problems if any, with the introduction of synthetic fuels.

The next highest percentage in the number of elastomers identified in the survey was elastomers containing Nitrile rubber, a copolymer of butadiene and varying contents of Arylonitrile. In previous studies, Nitrile elastomers used in selected injection pumps were switch-loaded between non-aromatic and aromatic fuels. In this study, the Nitrile elastomers started to lose volume immediately after submersion in non-aromatic fuel and continued in a downward spiral with some swell variations when submersed in aromatic fuel; however, always remaining in negative numbers throughout the switch loading between aromatic and non-aromatic fuels. Volume loss in injection pump elastomers may contribute to fuel leakage. Depending in the location and purpose of the elastomers, the leakage can either be internal or external. External leakage, however small, becomes critical and must be addressed immediately for safety reasons. Internal leakage, on the other hand, can be presented in a better perspective. In direct internal combustion engines, fuel not metered to the injectors, is returned to the main supply tank. Therefore, due to the continuous and significant amount of fuel circulation, internal leakage may not be noticeable, unless the high-pressure area of the pump is affected. Whenever high fuel pressurization is

decreased because of internal leakage, power loss and engine timing retardation can occur and affect the performance of the engine.

Butyl Rubber, a synthetic rubber produced by copolymerization of butylene and isoprene was identified as the material in the elastomers of the Bosch VE rotary pump and constitutes 8% of the elastomers identified. No known studies have determined butyl elastomers' compatibility with non-aromatic fuels. However because of its excellent impermeability, it is believed that in static applications problems are not anticipated.

Synthetic rubber is made from the polymerization of a variety of polymers and isobutylene. Synthetic rubber, although a broad term, was entered when elastomer composition was not identified by the pump manufacturer or specifically identified in any of the sources investigated.

Butadiene rubber was identified in three static applications in the Bosch in-line pump. As determined in Task II-B, switch loading of butadiene elastomers between non-aromatic and aromatic fuels showed an acceptable degree of volume gains and losses of less than 4%. Problems while using non-aromatic or low-aromatic fuel are not anticipated.

Fluorosilicone material was identified in one dynamic elastomer application in a specific model of the Stanadyne rotary pump. In a previous study, new and used Fluorosilicone seals exhibited large volume swells when switch loaded between non-aromatic and aromatic fuels. In this application, the Fluorosilicone seal is located in the main drive shaft between two Viton seals that prevent engine oil and fuel from commingling. Unless the Viton seal allows fuel seepage, it is not likely that the Fluorosilicone will ever be wetted with fuel. Therefore, no operational problems are anticipated when switching between non-aromatic and aromatic fuels.

Nylon rubber was identified in one dynamic application in a specific model of the Stanadyne rotary pump. The elastomer is identified as a spacer on the drive shaft that is located adjacent to the driveshaft seal and is not anticipated to be a leakage factor regardless of fuel used.

Viton, butadiene, Nitrile, and Fluorosilicone are the only materials that have been studied on the effects of switch loading between non-aromatic and aromatic fuels. Of these, the Nitrile elastomer exhibited the largest volume percent loss. The following segmented tables contain specific information on the different pumps identified in the Elastomer ID Table as containing Nitrile elastomers and denote the location of the seal and whether leakage if it occurs will be internal or external.

Equipment Type/ Engine/Fuel Pump	Possible Leakage- Internal/External	Dynamic/ Static	Seal / Gasket	NSN	Part Number
Recovery Vehicle M88A1 / 2, M728, AVLB AVDS 1790 Rotary Pump- Model PSB-12BT	External 8 ea	Static	O-ring, Fuel inlet/return hsng	5330005793156	MS28775-116
	External 1 ea	Static	O-ring, Fuel inlet housing cap	5331008195111	MS28778-24
	External 2 ea	Static	Gasket, Plunger bore screw	5330014338436	MS28775-017
	External 2 ea	Static	Gasket, Delivery valve	5330014338434	G410154
	External 2 ea	Static	O-ring, Hydraulic Head Assy	5331006086432	MS28775-237
	Internal 2 ea	Static	O-ring, Hydraulic Head Assy	5331005769733	MS28775-234
	Internal 4 ea	Dynamic	O-ring, Fuel Control Unit	5330006181920	MS28775-017

Equipment Type/ Engine/Fuel Pump	Possible Leakage- Internal/External	Dynamic/ Static	Seal / Gasket	NSN	Part Number
HMMWV Series GEP 6.2/6.5L Stanadyne Rotary	External	Static	Governor adjusting screw	5331006418283	11057

The Stanadyne rotary pump has one governor adjusting screw O-ring. When the governor has to be adjusted, the screw is turned in or out. However, the governor hardly ever needs adjusting, therefore, the potential for leakage is minimal. If leakage should occur, it will be external. There is a Viton replacement for this seal.

The model PSB 12BT pump is an oil-lubricated pump that has two separate hydraulic heads with 6 ports each. All the fuel is delivered to the hydraulic heads where it is pressurized, metered, and supplied to the injectors. If external leakage should occur, it would be in the fuel inlet and return O-rings and or the fuel inlet housing cap. The plunger bore and delivery valve gaskets are the least likely to leak because these seals are thick, flat, and static. Also, they require a specific torque when installed.

One head assembly seal and one fuel control seal in each hydraulic head are dual-purpose seals, which prevent lubricating oil and fuel from commingling. A leak in either of these seals will be internal and perhaps not cause operational problems for a period of time; however, It can cause fuel dilution and if undetected, may eventually cause engine damage. The PSB 12BT pump is the only pump where fuel and oil can commingle and the material of the seal preventing this occurrence contains Nitrile. The vehicles that use this pump are not high density however, they are high mission critical equipment and there are no substitute vehicles that can be used as replacements.

Equipment Type/ Engine/Fuel Pump	Possible Leakage- Internal/External	Dynamic/ Static	Seal / Gasket	NSN	Part Number
M939 Series 5 Ton Cummins 6CTA 8.3 Bosch In-Line	External	Static	Seal/Washer Fuel Gallery	5330121564593	

The fuel gallery seal/washer is the only seal that is Nitrile in the Bosch In-Line pump. Because the washer is a compression washer and is steel encapsulated with Nitrile rubber, once tightened, it is not likely to leak. If leakage occurs, it will be external.

<b>Equipment Type/ Engine/Fuel Pump</b>	<b>Possible Leakage- Internal/External</b>	<b>Dynamic/ Static</b>	<b>Seal / Gasket</b>	<b>NSN</b>	<b>Part Number</b>
Generator Set 60kW Allis Chalmers 3500 Stanadyne Rotary	Internal	Static	Seal, O-ring, regulator Assy	5331001715641	12406
	Internal	Static	Seal, O-ring, filter element	5331006418283	11507
	Internal	Dynamic	Seal, O-ring, control rod guide	5331009378477	13550
	External	Static	Seal, O-ring, plug piston hole	5331009746643	12764
	External	Static	Seal, O-ring, plug	5331009364587	12766
	External	Static	Gasket, Timing window	5330005063975	10574
	Internal	Dynamic	Seal, O-ring, drive shaft Assy	5331001715641	12406
These generators are not in production and are being replaced with the Tactical Quiet generator sets with the John Deere engine. Approximately 30% are still in the inventory primarily in National Guard and Army Reserve units and should be replaced with the TQ sets by 2010 or sooner.					

<b>Equipment Type/ Engine/Fuel Pump</b>	<b>Possible Leakage- Internal/External</b>	<b>Dynamic/ Static</b>	<b>Seal / Gasket</b>	<b>NSN</b>	<b>Part Number</b>
Generator Set 30kW Hercules D298ERX-37 Stanadyne Rotary	Internal	Static	Seal, O-ring, filter element	5310008984927	15627
	External	Static	Seal, O-ring, cam adjusting screw	5331006418283	11507
	External	Static	Seal, O-ring, transfer pump	5331013444225	26965
These generators are not in production and are being replaced with the Tactical Quiet generator sets with the John Deere engine. Approximately 30% are still in the inventory primarily in National Guard and Army Reserve units and should be replaced with the TQ generator sets by 2010 or sooner.					

#### 4.0 SUMMARY AND CONCLUSION

- Elastomeric components found in injection pumps of selected high-density combat, wheeled and ground support equipment, were identified.
- Engine manufacturer and model numbers of selected equipment were identified and a listing was generated showing fuel injection pump manufacturers, and the composition of the elastomers within each pump listed.
- Injection pump manufacturers were contacted to obtain elastomer composition and schematic drawings showing location of elastomers within the pump.
- An injection pump elastomer identification table was developed.

- An estimation was made on the potential for injection pump leakage based on composition of elastomers and their location within the pump, and whether leakage, if it occurred, would be external or internal.
- Of the pumps identified, the model PSB 12BT pump fueling the AVDS 1790 engines in the recovery vehicle, engineer vehicle, and the AVLB bridge launcher is the only pump that raises the most concern with the use of non-aromatic fuel. The reason being that there are two head assembly static seals in each hydraulic head and two fuel control dynamic seals made out of butadiene and Arylonitrile material. These seals are dual-purpose seals that prevent lubricating oil and fuel from commingling within the pump. The fact that the material is a combination of butadiene and Arylonitrile may lessen the effect of shrinkage as opposed to pure Nitrile material.

## **5.0 RECOMMENDATIONS**

Previous studies have found that elastomers containing Nitrile material exhibit a greater degree of mass and volume percent loss when exposed to non-aromatic fuels than do elastomers that are manufactured from other materials. The model PSB 12BT injection pump that fuels the M88 recovery vehicle, M728 combat engineer vehicle, and the AVLB bridge launcher, contain critical seals made out of Nitrile material. Therefore it is recommended that further studies be conducted to examine the effects of these seals when exposed to non-aromatic fuels

## **V. TASK V: JP-8/S-8 FUEL BLEND STUDY**

### **1.0 APPROACH**

Fuel properties were determined for a 50/50% vol. Blend of S-8 and JP-8 petroleum based aviation fuel. The blend was analyzed according to the testing protocols listed in DEF STAN 91-91 Table 1.



## 2.0 RESULTS

The results are presented in Table V-1. Two properties of the blend were retested because of inconsistent results (% Naphthalenes by D1840, Flash Point by D3828). The lubricity results are presented in Table V-2. Tables V-1 and V-2 contain the complete, final data set. The data was examined for compliance with JP-8 and DEF STAN 91-91 specifications. The following results were outside of the specification limits:

- The base fuel (JP-8), S-8, and the blend were outside of the conductivity limit
- The standard BOCLE result for S-8 was high
- The density for S-8 and the blend was low
- D86 residue and loss were slightly high for the blend
- Hydrogen content of the base JP-8 was slightly low

**Table V-1. Fuel Blend Property Results**

Property Units		MIL-DTL-83133 (JP-8) Specification Requirements	DEF STAN 91-91	CL03-0002 JP-8 Base Fuel AL-26936	Blend <sup>1</sup> AL-27108	S-8 Base Fuel AL-27074
Ball-On-Cylinder Lubricity Evaluator, D 5001, avg. wear scar diameter	mm	NR <sup>2</sup> (0.65, max per MIL-PRF-25017)	0.85 <sup>3</sup>	0.51	0.50	0.98
Cetane Number, D 613		NR	NR	50	54	61
Cetane Number, IQT		NR	NR	48	NR	58
Cetane Index, D 976		Report	NR	43	53	64
Cetane Index, D 4737		NR	NR	46	56	69
Color, Saybolt, D 156		Report	Report	+15	+24	+30
Conductivity, D 2624	pS/m	<sup>4</sup>	50-450 <sup>5</sup>	10	0	0
Copper Strip Corrosion, 2 hr @ 100°C, D 130	Visual rating	1, max	1, max	1A	1A	1A
Density @ 15°C, D 4052	kg/m <sup>3</sup>	775 – 840	775.0 – 840.0	793.0	773.9	754.8

NR = Not Required by Specification

<sup>1</sup> 1:1 Blend of AL-26936-F (JP-8): AL-27074 (S-8)

<sup>2</sup> The contractor shall blend a corrosion inhibitor conforming to MIL-PRF-25017 into the F-34 (JP-8) grade fuel. The corrosion inhibitor additive is optional for F-35. The amount added shall be equal to or greater than the minimum effective concentration and shall not exceed the maximum allowable concentration listed in the latest revision of *QPL-25017*. The contractor or transporting agency, or both, shall maintain and upon request shall make available to the Government evidence that the corrosion inhibitors used are equal in every respect to the qualification products listed in *QPL-25017*. The point of injection of the corrosion inhibitor shall be determined by agreement between the purchasing authority and the supplier.

<sup>3</sup> The requirement to determine lubricity applies only to fuels containing more than 95% hydroprocessed material and where at least 20% is severely hydroprocessed and for all fuels containing synthetic components. The limit applies only at the point of manufacture. Severely hydroprocessed components are defined as petroleum derived hydrocarbons that have been subjected to a hydrogen partial pressure of greater than 7000 kPa (70 bar or 1015 psi) during manufacture.

<sup>4</sup> The conductivity must be between 150 and 450 pS/m for F-34 (JP-8) and between 50 and 450 pS/m for F-35, at ambient temperature or 29.4°C (85°F), whichever is lower, unless otherwise directed by the procuring activity. In the case of JP-8+100, JP-8 with the thermal stability improver additive (see 3.3.6), the conductivity limit must be between 150 to 700 pS/m at ambient temperature or 29.4°C (85°F), whichever is lower, unless otherwise directed by the procuring activity.

<sup>5</sup> The conductivity limits are mandatory for product to meet this specification. However, it is acknowledged that in some manufacturing and distribution systems it is more practical to inject static dissipater additive further downstream. In such cases the Certificate of Quality for the batch should be annotated thus: “Product meets requirements of Defense Standard 91-91 except for electrical conductivity.” Due to high flow rates and very fine filtration used when fueling aircraft, it is absolutely essential that these conductivity limits are met at the point of delivery into aircraft.

**Table V-1. Fuel Blend Property Results (continued)**

Property Units		MIL-DTL-83133 (JP-8) Specification Requirements	DEF STAN 91-91	CL03-0002 JP-8 Base Fuel AL-26936	Blend AL-27108	S-8 Base Fuel AL-27074
Microseparator, D 3948		<sup>6</sup>	85, min	97	96	100
Naphthalenes, D 1840	vol%	3.0, max	3.00, max	1.63	0.81	<0.01
	Mass%	NR	NR	2.06	1.05	<0.01
Net Heat of Combustion, D 240	BTU/lb	NR	NR	18.745	18,632	18,907
	MJ/kg	42.8, min	42.8, min	43.6	43.3	44.0
Net Heat of Combustion, D 3338	BTU/lb	NR	NR	18,627	18,803	18,975
Smoke Point, D 1322		25, MIN	25, MIN	25	36.8	>50
Sulfur, Mercaptan, D 3227	Mass%	0.002, max	0.0030, max	<0.0003	0.0003	<0.0003
Sulfur, Total, D 5453	Ppm	3000, max	3000, max	87	46	<1
Thermal Oxidation Stability (JFTOT), 260°C, D 3241	Change in pressure drop, mm Hg	25, max	25, max	1	0	2
	Heater tube deposit, visual rating	<3 <sup>7</sup>	<3 <sup>8</sup>	<2	1	2
Total Acid Number, D 3242	Mg KOH/g	0.015, max	0.015, max	0.011	0.007	<0.001

NR = Not Run

<sup>6</sup> The minimum Microseparator rating using a Micro-Separator (MSEP) shall be as follows:

JP-8 Additives	MSEP Rating, min.
Antioxidant (AO)*, Metal Deactivator (MDA)*	90
AO*, MDA*, and Fuel System Icing Inhibitor (FSII)	85
AO*, MDA*, and Corrosion Inhibitor/Lubricity Improver (CI/LI)	80
AO*, MDA*, FSII, and CI/LI)	70

*\*Even though the presence or absence does not change these limits, samples submitted for specification conformance testing shall contain the same additives present in the refinery batch. Regardless of which minimum the refiner elects to meet, the refiner shall report the MSEP rating on a laboratory hand blend of the fuel with all additives required by the specification.*

<sup>7</sup> Peacock or abnormal color deposits result in a failure.

<sup>8</sup> Peacock or abnormal color deposits result in a failure.

**Table V-1. Fuel Blend Property Results (continued)**

Property Units		MIL-DTL-83133 (JP-8) Specification Requirements	DEF STAN 91-91	CL03-0002 JP-8 Base Fuel AL-26936	Blend AL-27108	S-8 Base Fuel AL-27074
Distillation, D 86	°C @ vol% evap. IBP 10 20 30 40 50 60 70 80 90 95 FBP residue loss	Report 205, max Report --- --- Report --- --- --- Report --- --- 300, max 1.5, max 1.5, max	Report 205, max Report --- --- Report --- --- --- Report --- --- 300, max 1.5, max 1.5, max	--- 160 166 --- --- 190 --- --- --- 235 --- 256 1.2 0.4	145 161 168 176 184 192 202 213 225 240 251 259 1.7 1.6	159 171 177 --- --- 201 --- --- --- 248 --- 272 1.0 0
Existent Gum, D 381	mg/100 mL	7.0, max	7, max	<0.1	1.5	1.0
Flash Point, D 56	°C	38, min	38, min	38	41	44
Flash Point, D 93	°C	38, min	NR	41	44	46
Flash Point, D 3828	°C	38, min	38, min	41	44	44
Freezing Point, D 2386 <sup>9</sup>	°C	-47, max	-47, max	-49	-52	-58
Freezing Point, D 5771	°C	NR	NR	NR	NR	-58
Freezing Point, D 5972	°C	-47, max	NR	-48	Erratic Instrument Reading No Result	Erratic Instrument Reading No Result

<sup>9</sup> This is the referee test method.

**Table V-1. Fuel Blend Property Results (continued)**

Property Units		MIL-DTL-83133 (JP-8) Specification Requirements	DEF STAN 91-91	CL03-0002 JP-8 Base Fuel AL-26936	Blend AL-27108	S-8 Base Fuel AL-27074
Freezing Point, D 5982	°C	NR	NR	NR	NR	-58
Hydrocarbon Type, F.I.A., D 1319	vol%	Aromatics: 25.0, max	Aromatics: 25.0, max	Aromatics: 16.8 Saturates: 82.2 Olefins: 1.0	Aromatics: 7.1 Saturates: 92.3 Olefins: 0.6	Aromatics: 0.5 Saturates: 99.0 Olefins: 0.5
Hydrogen Content, D 5291	mass %	13.4, min	NR	13.15	14.5	15.2
Kinematic Viscosity @ -20°C, D 445	cm <sup>2</sup> /s	8.0, max	8.000, max	3.48	3.87	4.38
Kinematic Viscosity @ 40°C, D 445	cm <sup>2</sup> /s	NR	NR	1.14	1.21	1.35

**Table V-2. Lubricity Results with AL-26955A (Ondeo/Nalco Additive) CI/LE**

Fuel Type	BOCLE, mm	HFRR, $\mu$ m	SLBOCLE, g
S-8 + 12 mg/L CI/LE	0.72	765	1350
S-8 + 22.5 mg/L CI/LE	0.57	735	1650
S-8/JP-8 Blend 50/50 + 12 mg/L CI/LE	0.51	650	2350
S-8/JP-8 Blend 50/50 + 22.5 mg/L CI/LE	0.50	650	3150
S-8/JP-8 Blend 50/50	0.50	695	2350
JP-8, AL-26936	0.51	720	2150

## **VI. TASK VI: BOCLE DATA FOR REFERENCE FLUIDS**

### **1.0 APPROACH**

The standard BOCLE ASTM D5001 test was conducted on the reference fluids for the ground fuel lubricity tests ASTM D6078 and ASTM D6079.

### **2.0 RESULTS**

The BOCLE results are shown below:

- Reference Fluid A: 0.56-mm average wear scar diameter in the BOCLE test.
- Reference Fluid B: 0.85-mm average wear scar diameter in the BOCLE test.

The data were transmitted to TARDEC for their use.

## APPENDICES

### Title

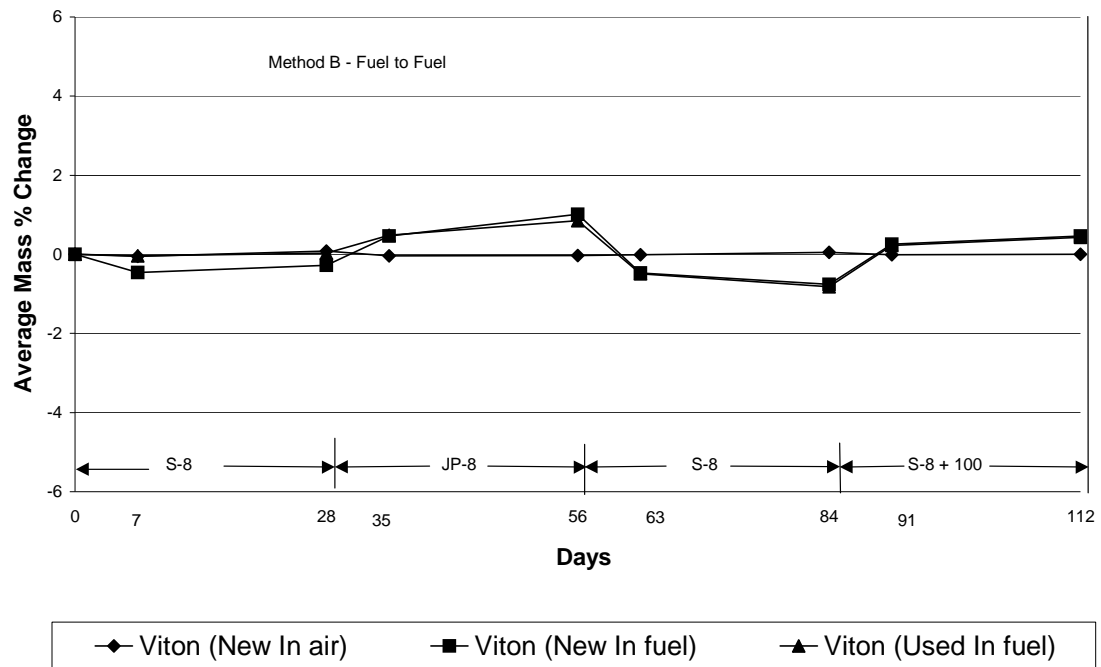
- II-A Grouped Elastomer Data, by Elastomer Type for Each Pump, Change Calculated by Method B
- II-B Stanadyne Pump, Data for Individual Elastomers, Change Calculated by Method A (Cumulative)
- II-C Bosch Pump, Data for Individual Elastomers, Change Calculated by Method A (Cumulative)
- II-D Detroit Diesel Unit Injector, Data for Individual Elastomers, Change Calculated by Method A (Cumulative)
- IV-A Injection Pump Elastomer Identification Table
- IV-B Schematic Drawings Showing Location of Elastomers within the Pumps

## **APPENDIX II-A**

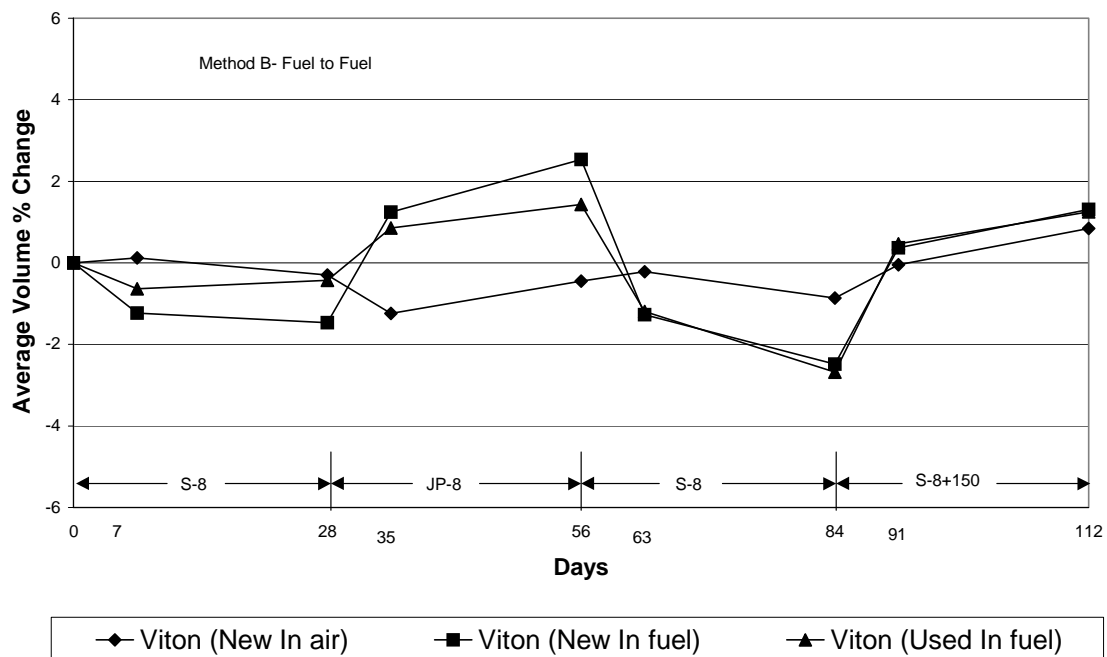
**Grouped Elastomer Data, by Elastomer Type for Each Pump  
Change Calculated by Method B**



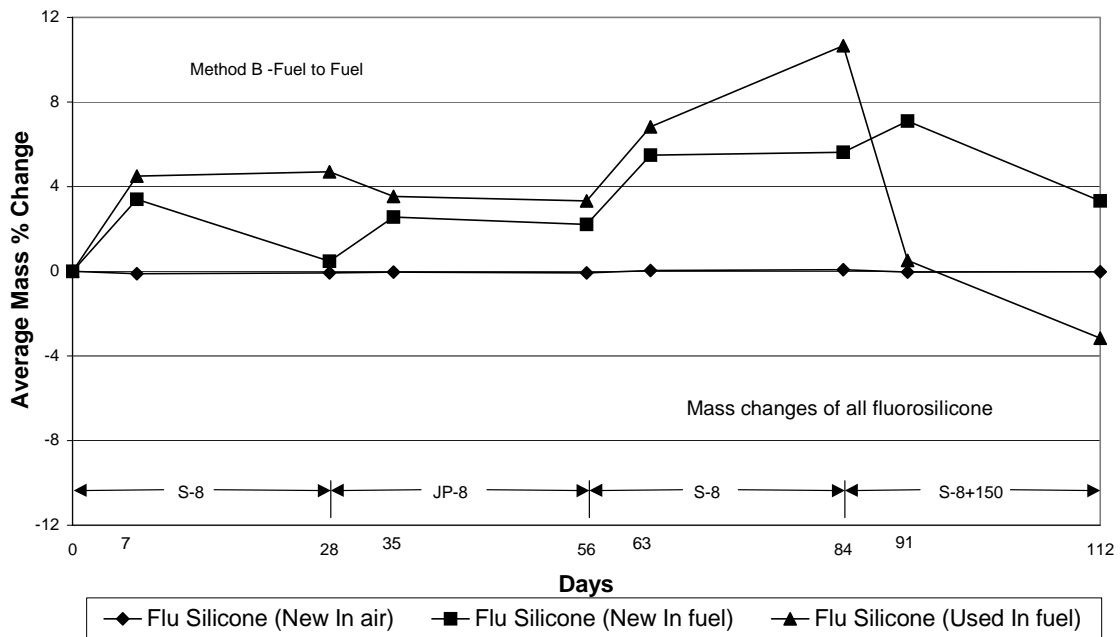
### Stanadyne Injection Pump Viton Elastomers Mass Changes in Fuel



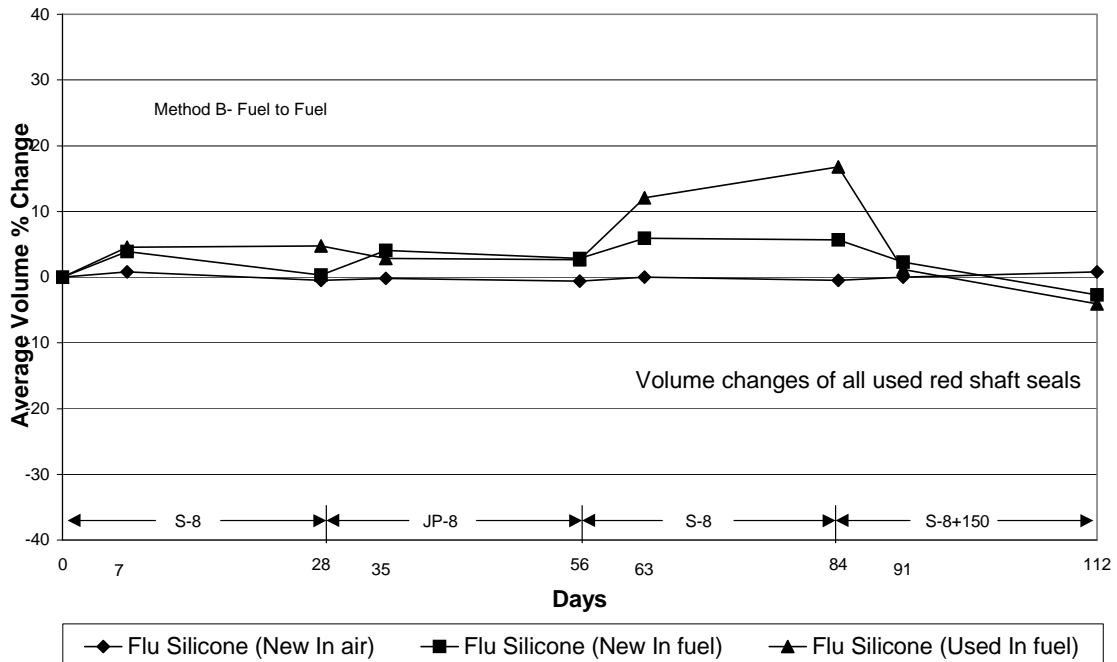
### Stanadyne Injection Pump Viton Elastomers Volume Changes in Fuel



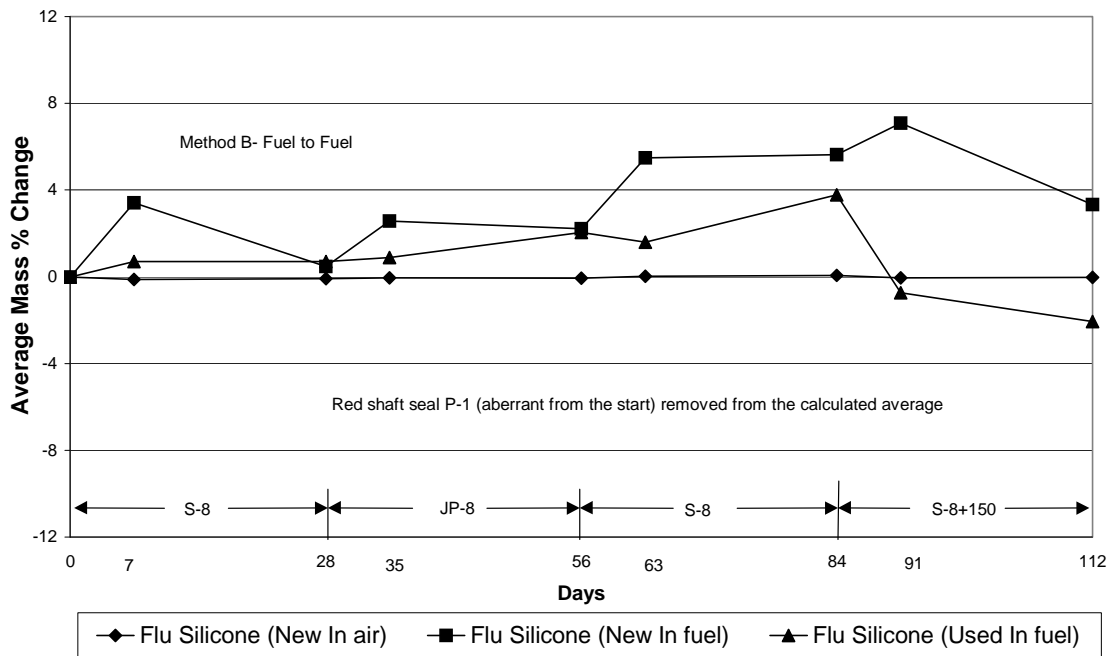
### Stanadyne Injection Pump Fluorosilicone Elastomers Mass Changes in Fuel



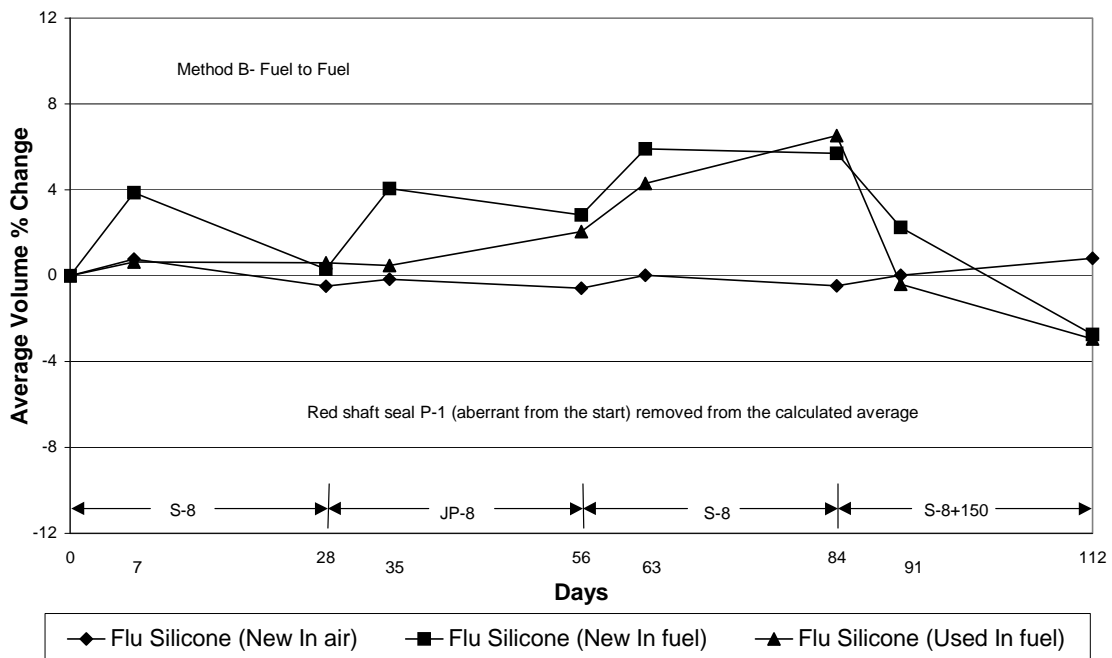
### Stanadyne Injection Pump Fluorosilicone Elastomers Volume Changes in Fuel



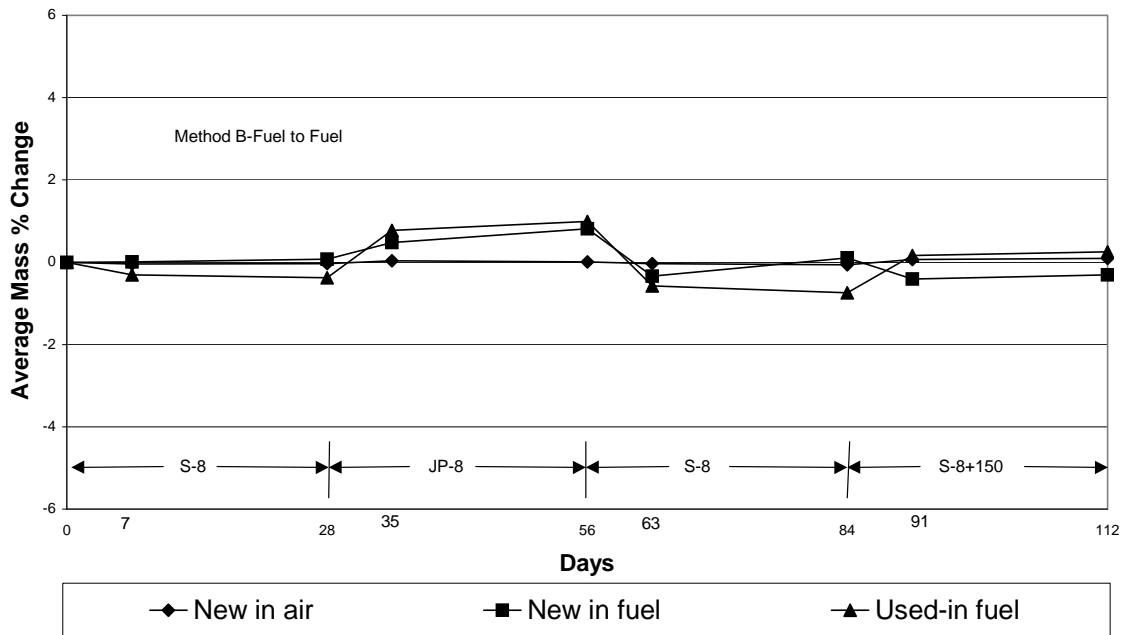
### Stanadyne Injection Pump Fluorosilicone Elastomers Mass Changes in Fuel



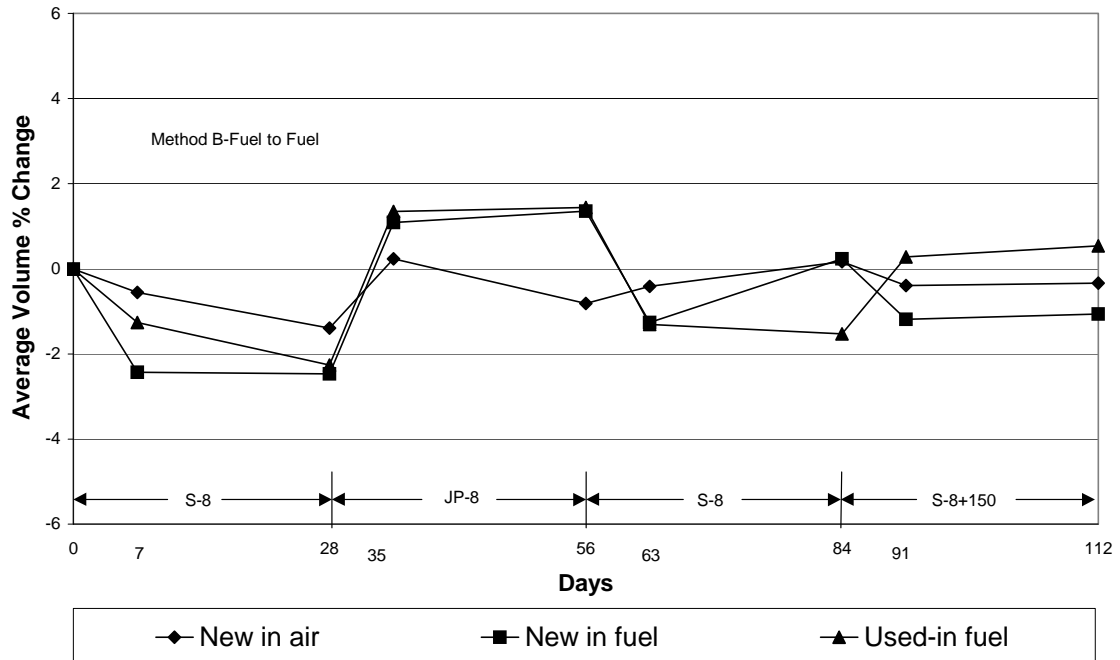
### Stanadyne Injection Pump Fluorosilicone Elastomers Volume Changes in Fuel



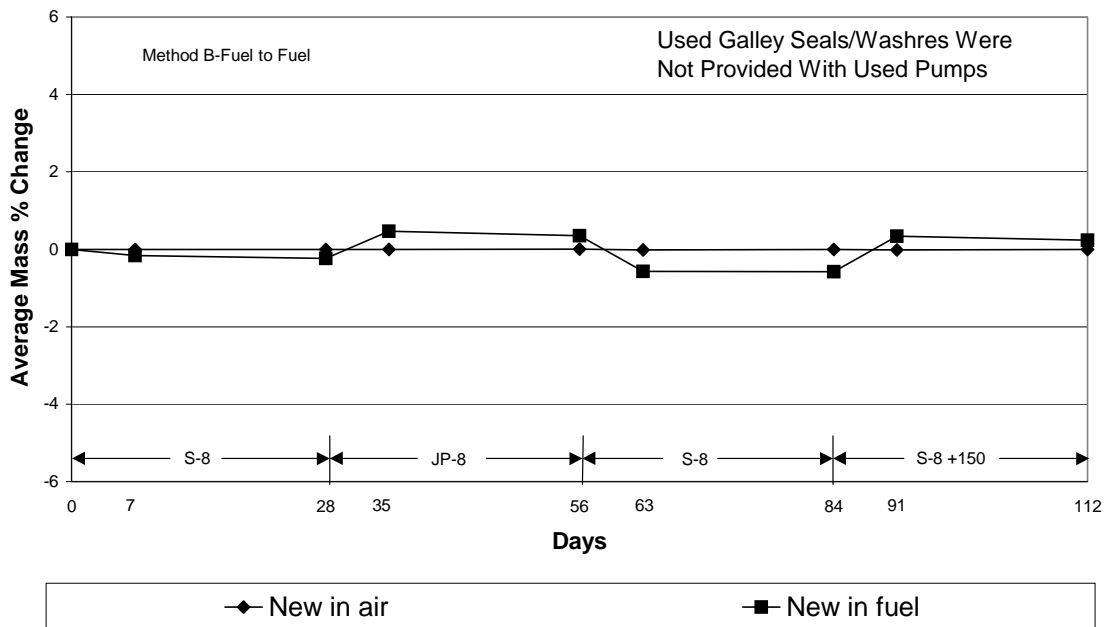
### Bosch In-Line Injection Pump Butadiene Elastomers Mass Changes in Fuel



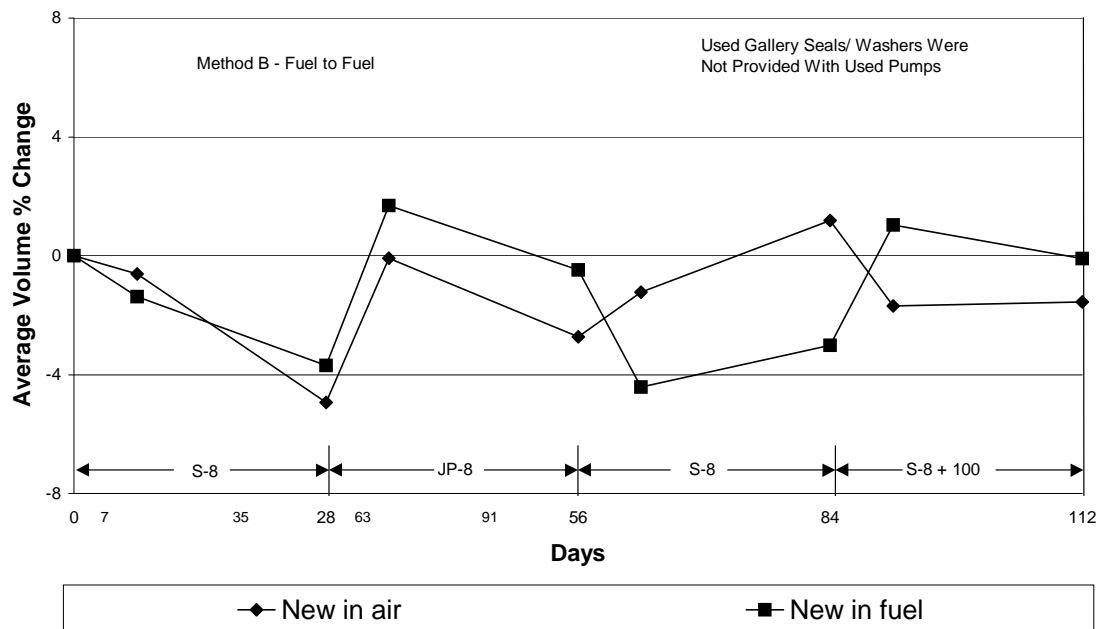
### Bosch In-Line Injection Pump Butadiene Elastomers Volume Changes in Fuel



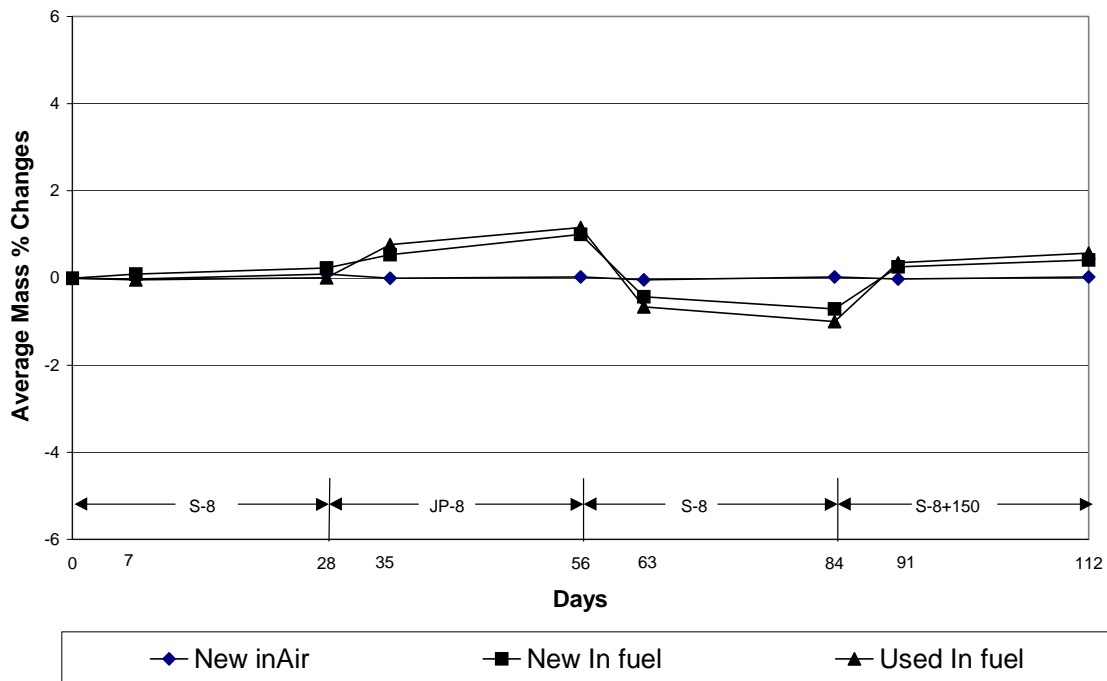
### Bosch In-Line Injection Pump Nitrile Fuel Gallery Seal/Washer Mass Changes in Fuel



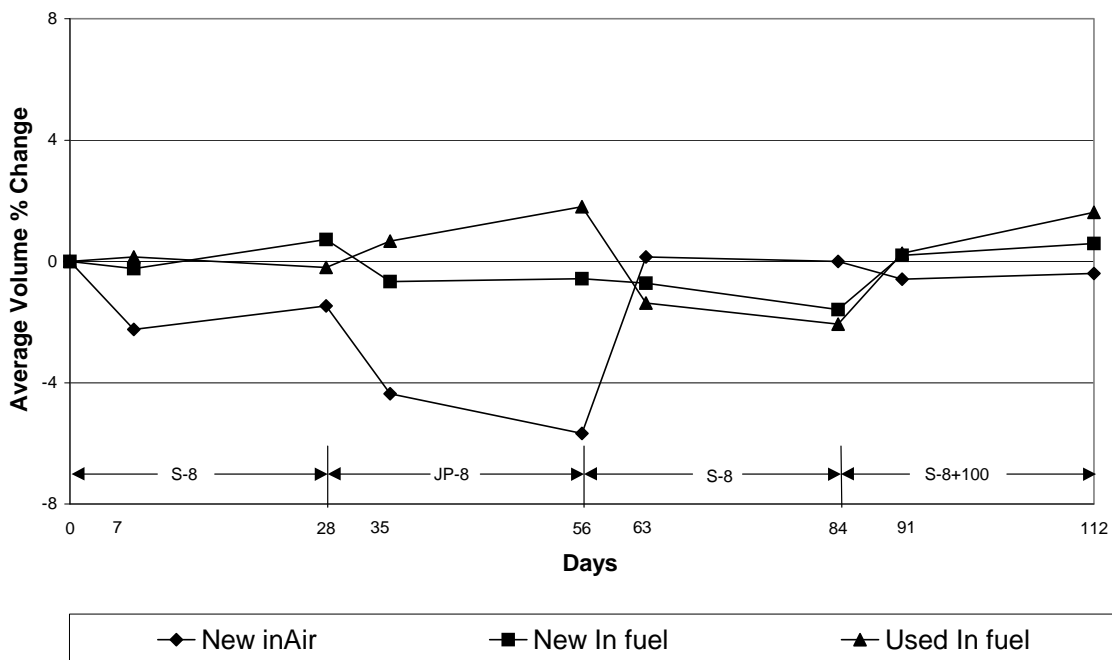
### Bosch In-Line Injection Pump Nitrile Fuel Gallery Seal/Washer Volume Changes in Fuel



**Detroit Diesel Unit Injector Viton Elastomers Mass Changes In Fuel**



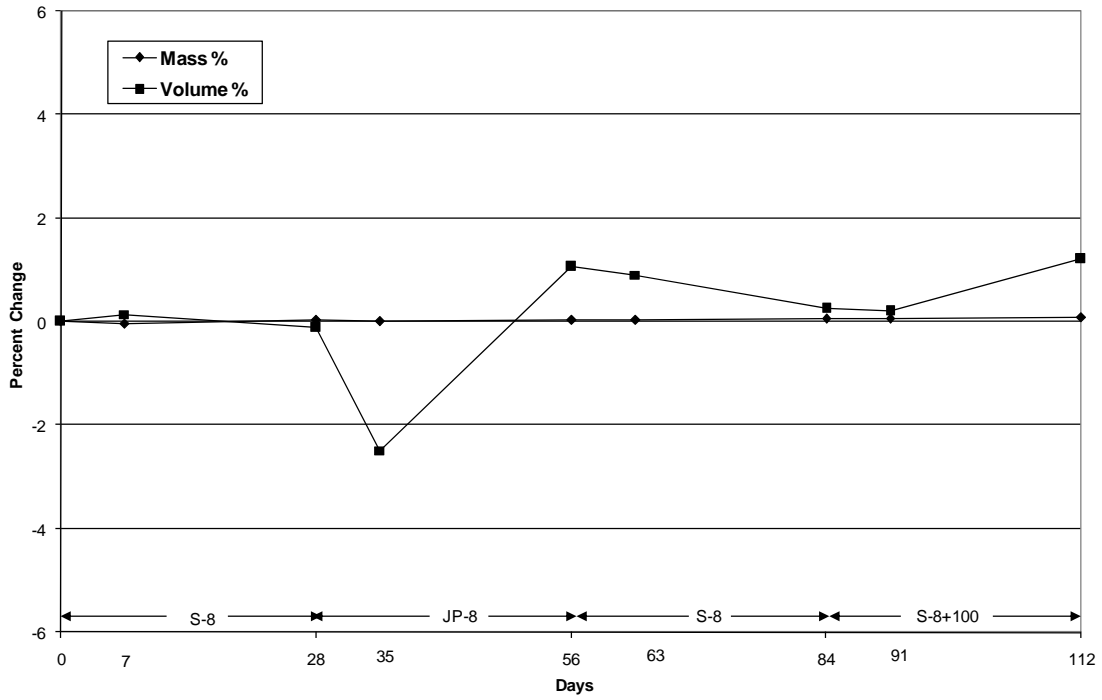
**Detroit Diesel Unit Injector Viton Elastomers Volume Changes In Fuel**



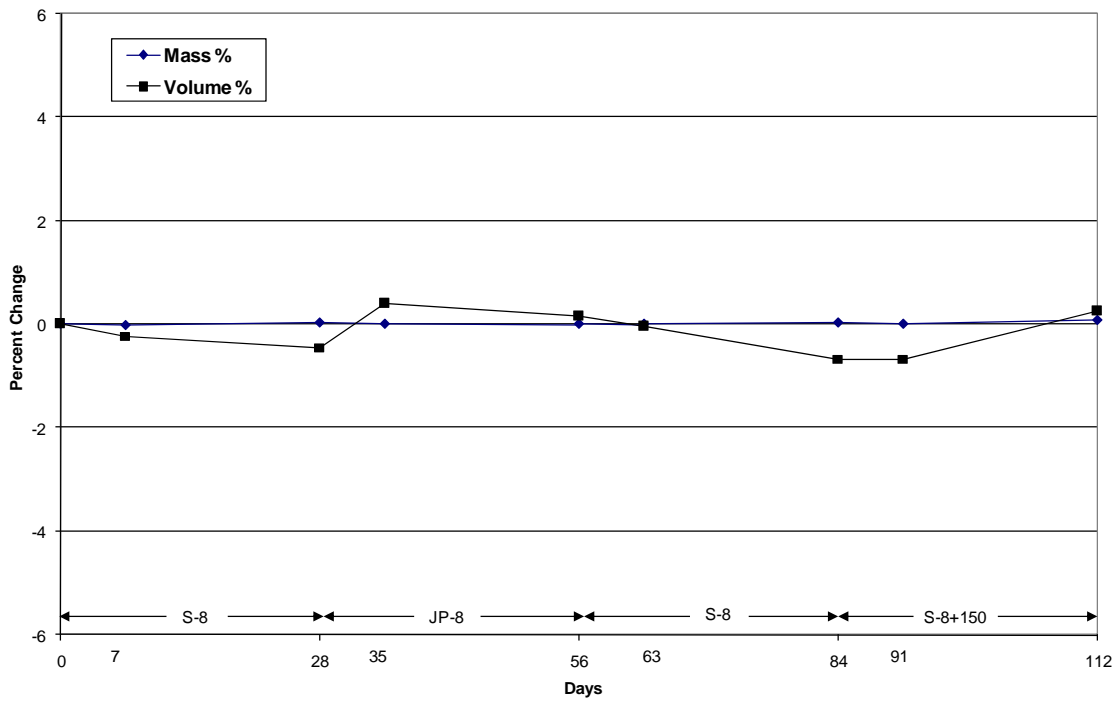
## **APPENDIX II-B**

**Stanadyne Pump  
Data for Individual Elastomers  
Change Calculated by Method A (Cumulative)**

Stanadyne Pump New Viton Head & Rotor Assembly 0-Ring in Air Na-1

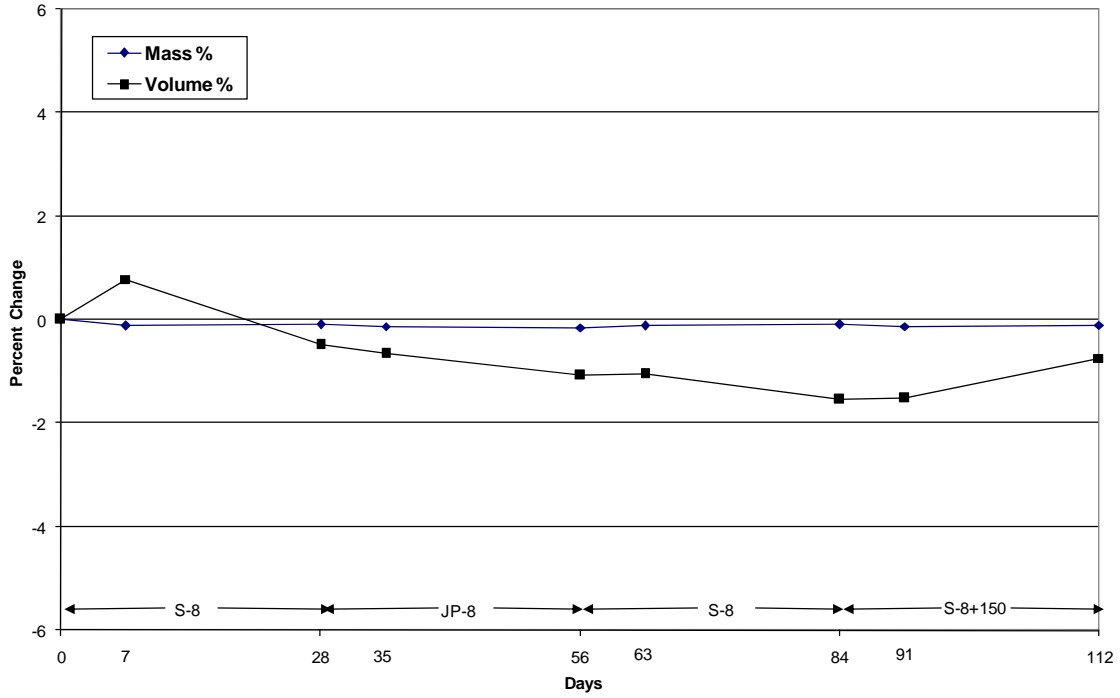


Stanadyne Pump New Transfer Pump Viton 0-Ring in Air Na-2

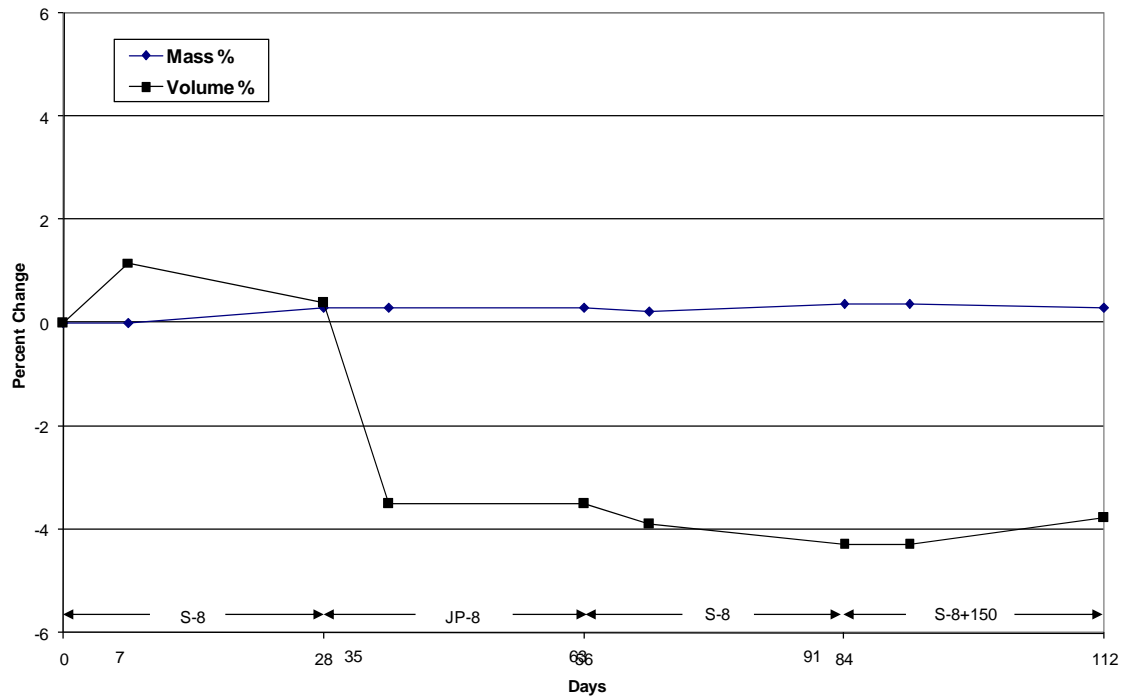




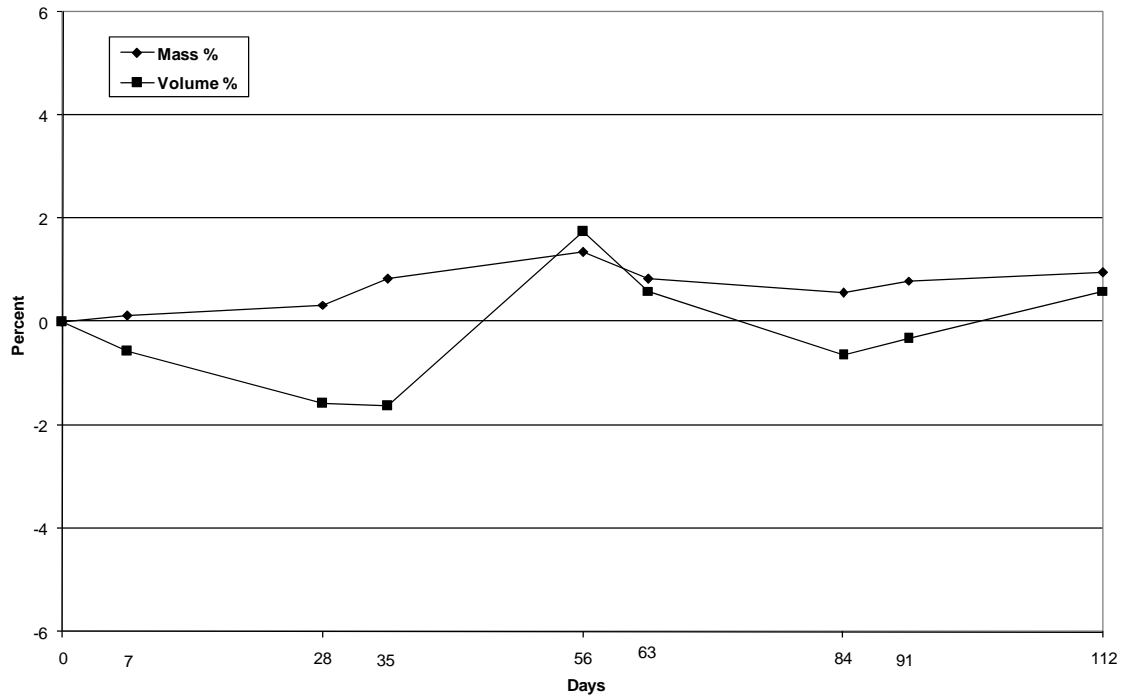
Stanadyne Pump New Red Fluorosilicone Shaft Seal in Air Na-3



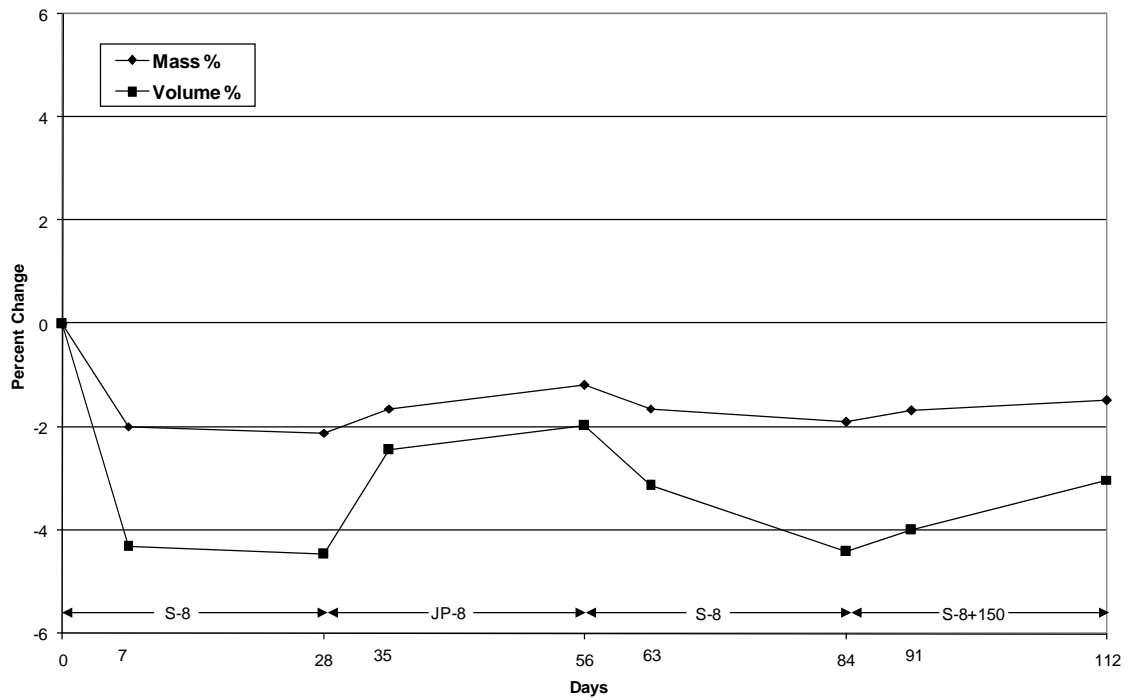
Stanadyne Pump New Viton Governor Stud Guide O-Ring in Air Na-5

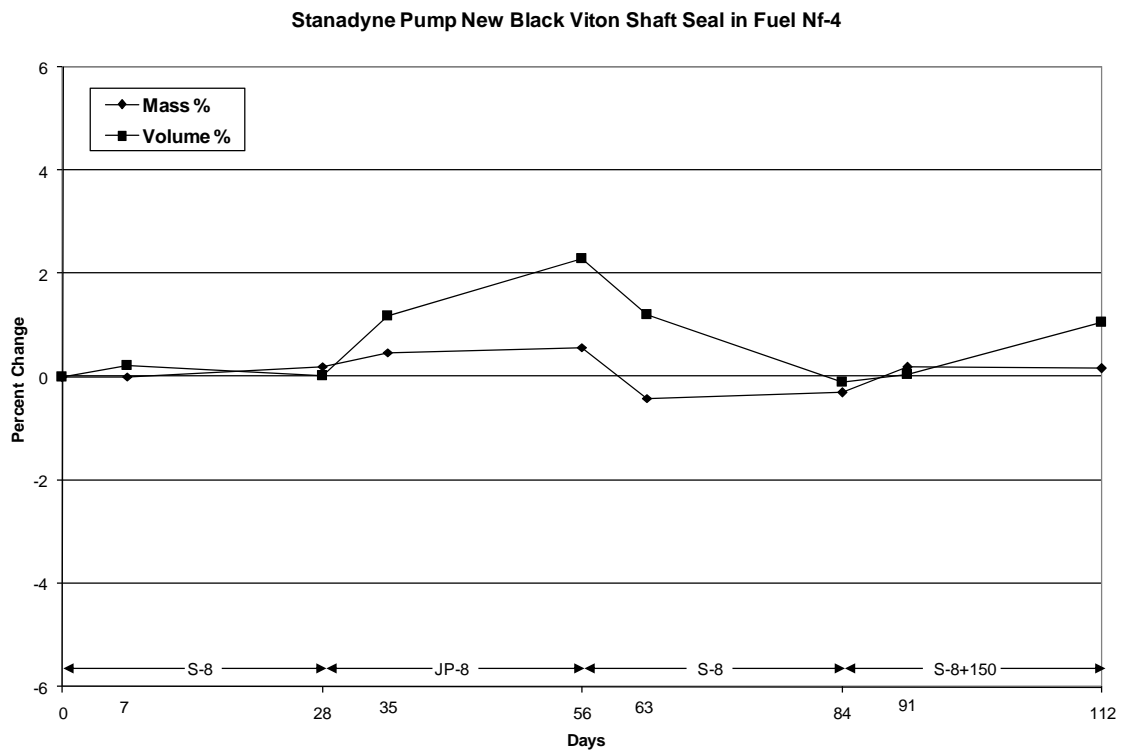
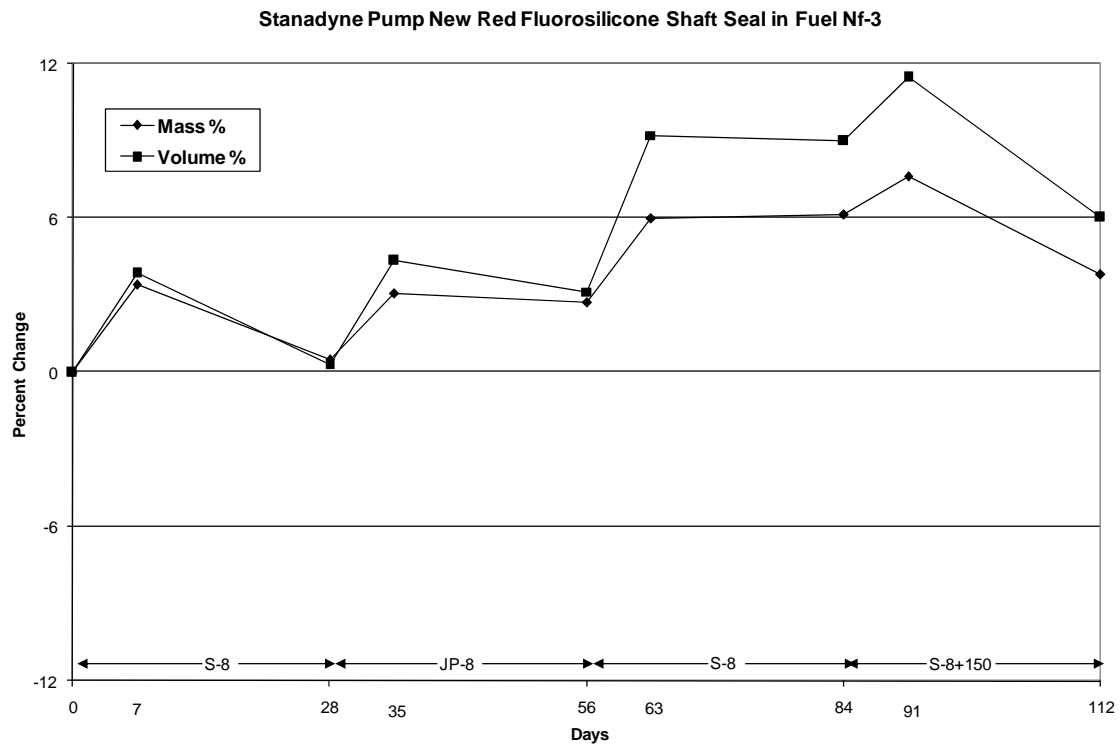


Stanadyne Pump New Viton Head & Rotor Assembly 0-Ring in Fuel NF-1

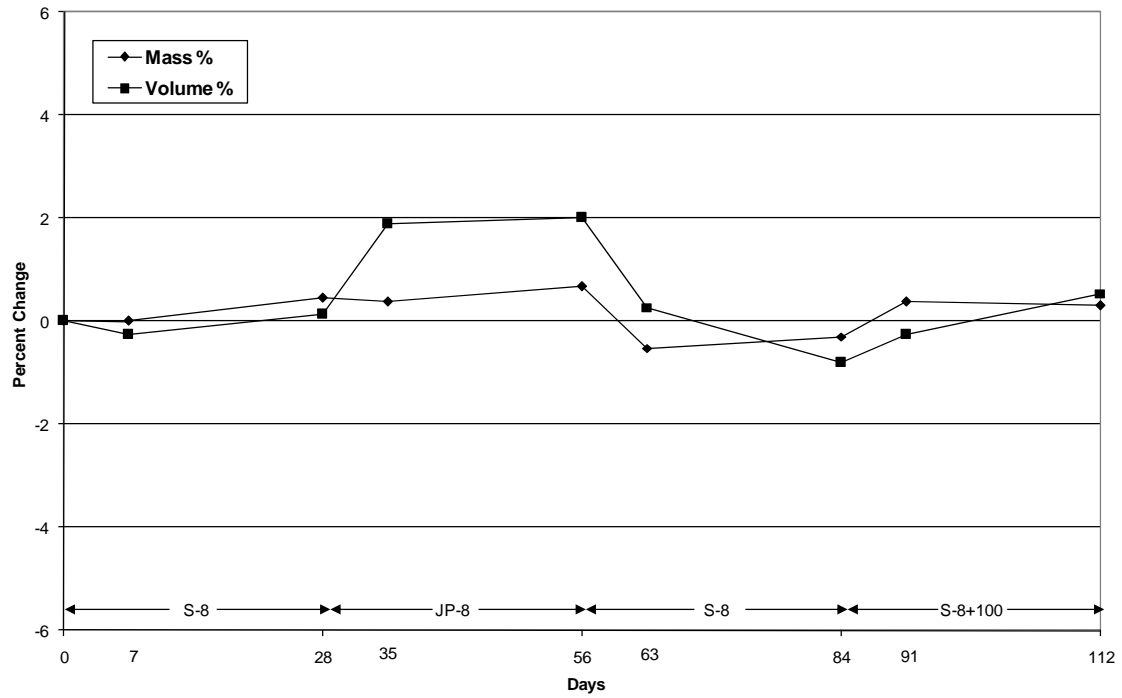


Stanadyne Pump New Transfer Pump Viton 0-Ring in Fuel Nf-2

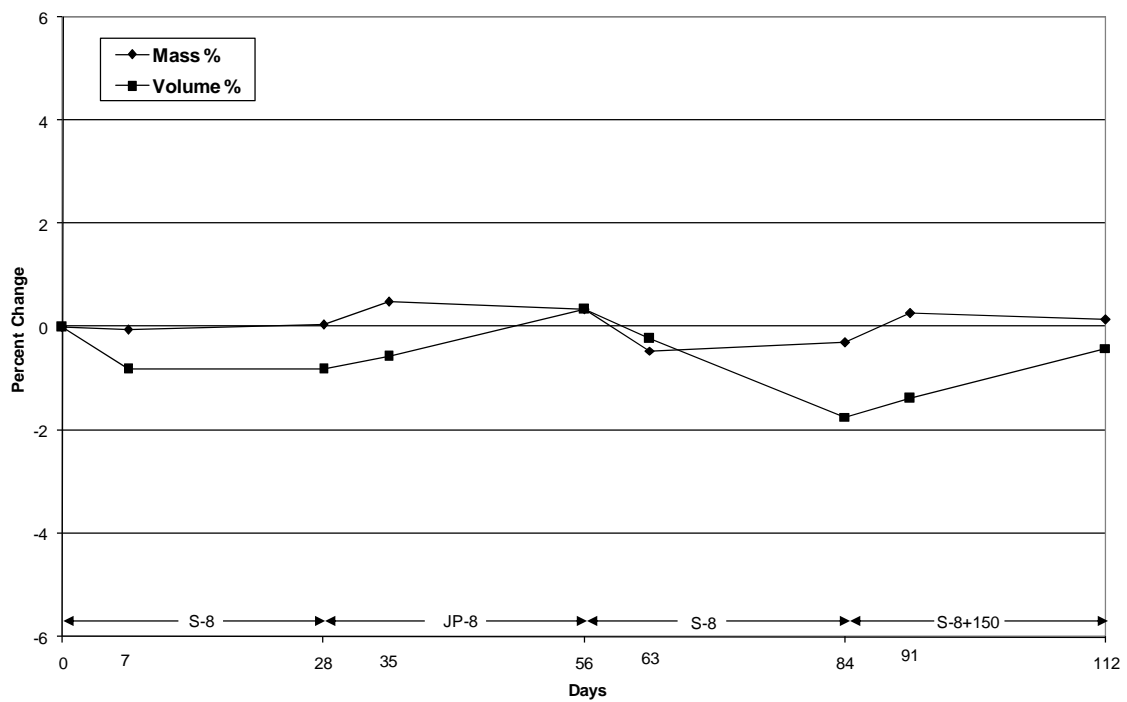


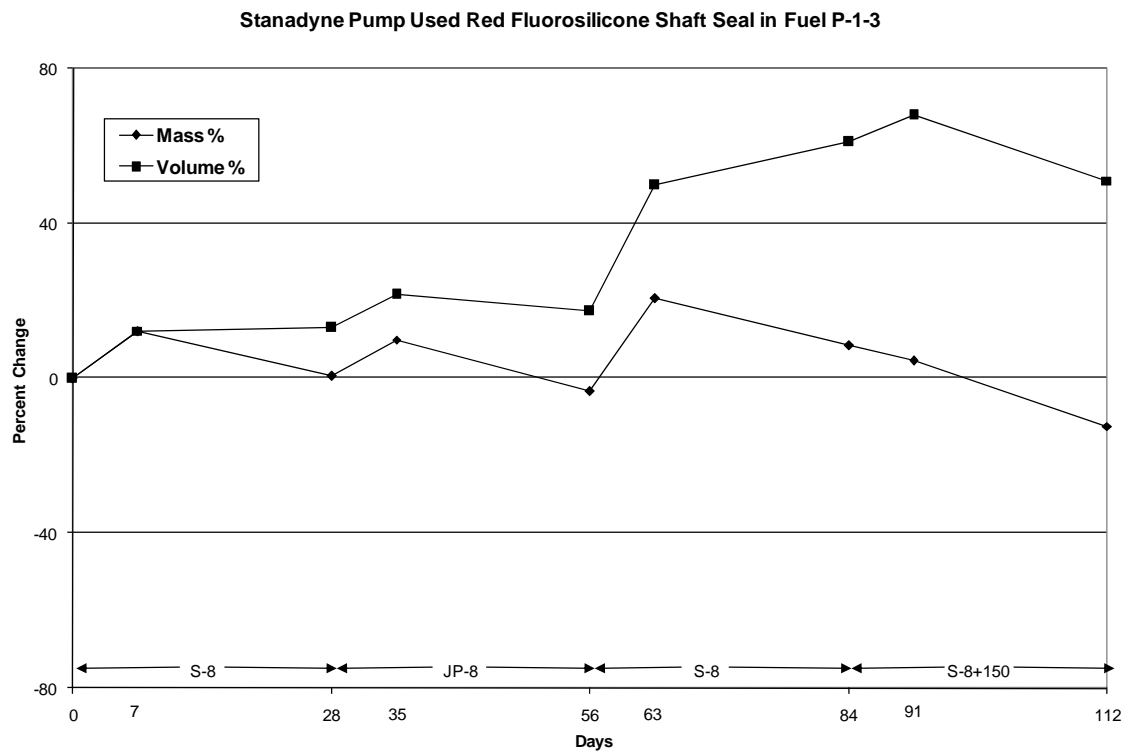
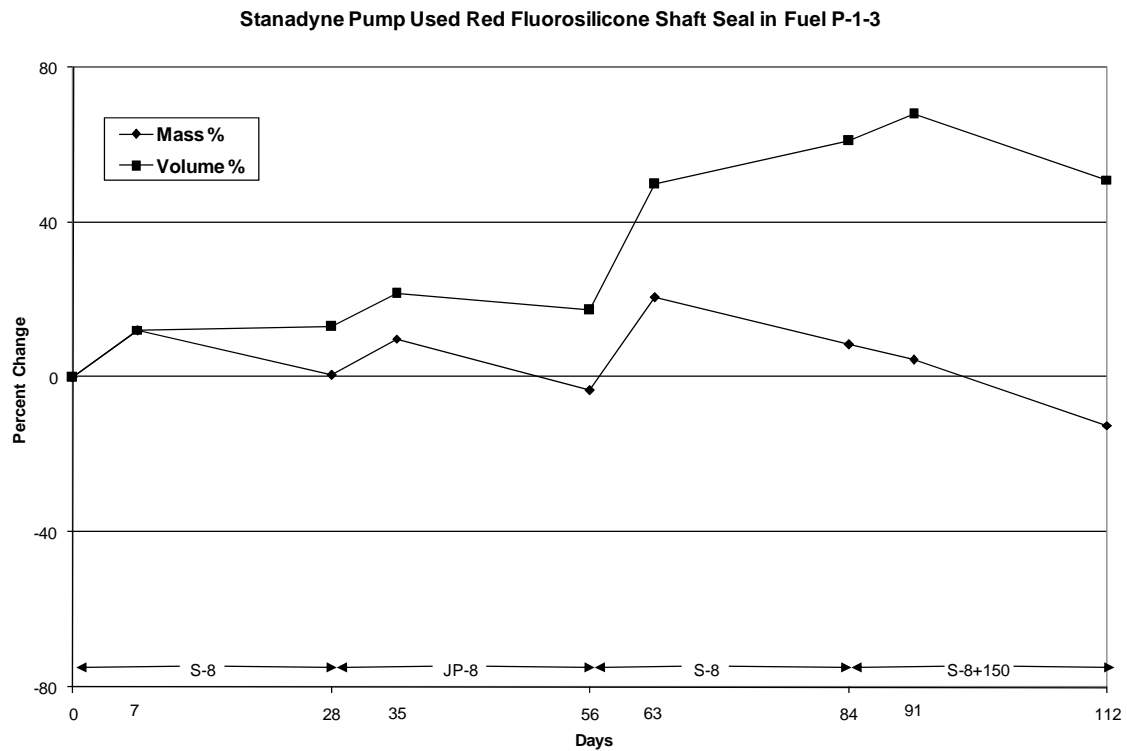


Stanadyne Pump New Viton Governor Stud Guide O-Ring in Fuel Nf-5

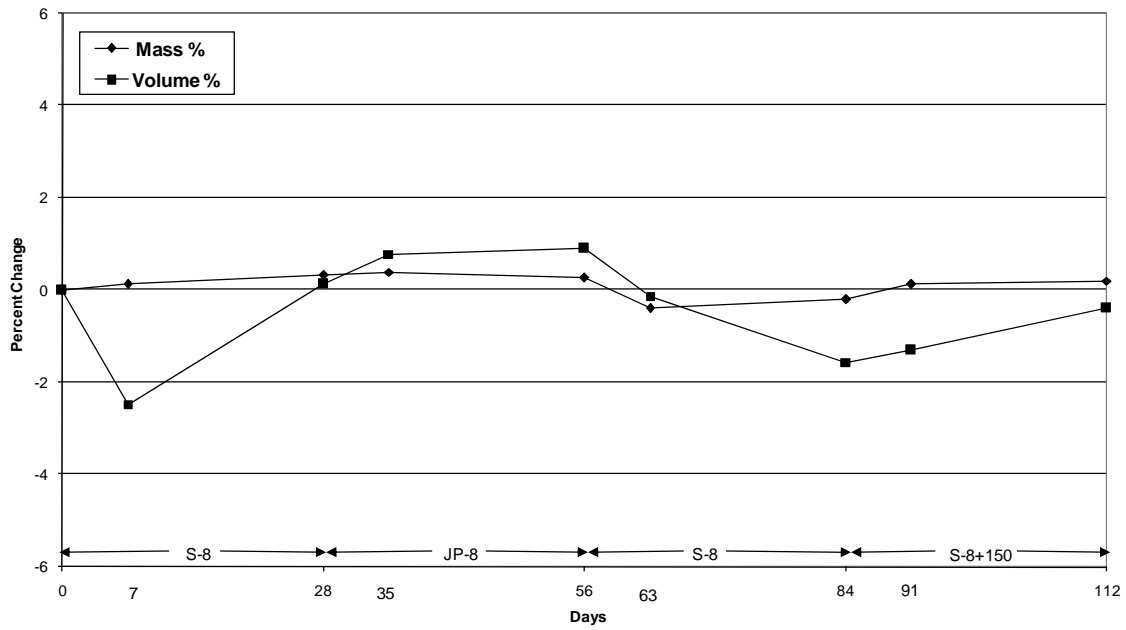


Stanadyne Pump Used Viton Head & Rotor Assembly O-Ring in Fuel P-1-1

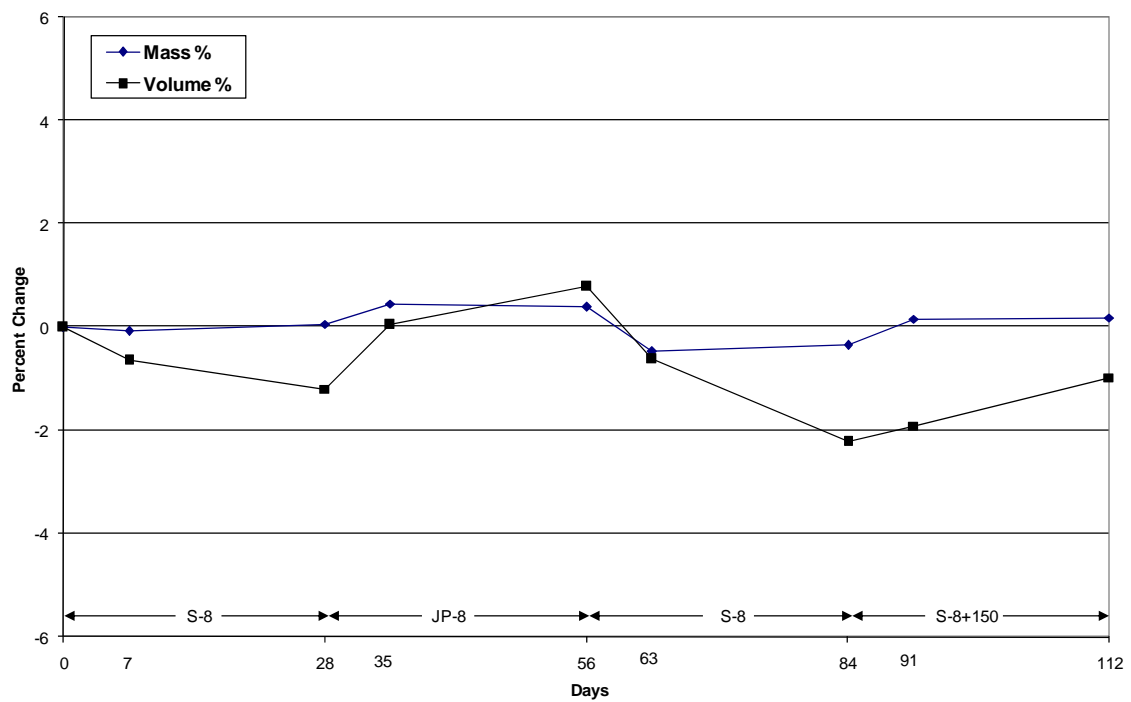




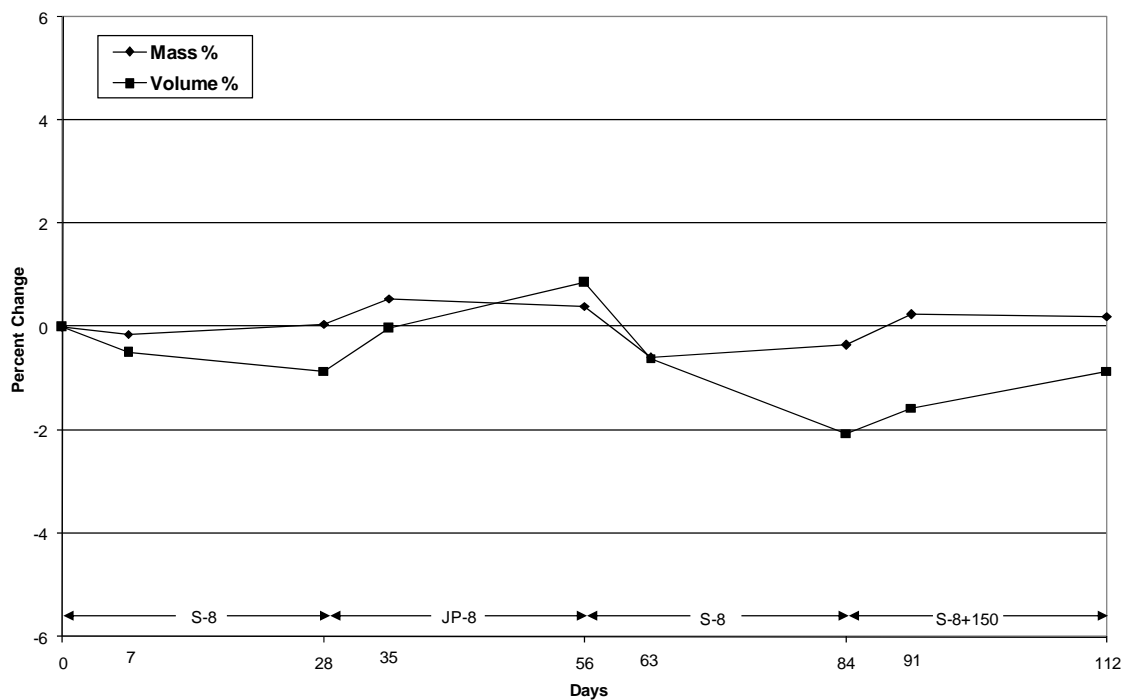
Stanadyne Pump Used Viton Governor Stud Guide O-Ring in Fuel P-1-5



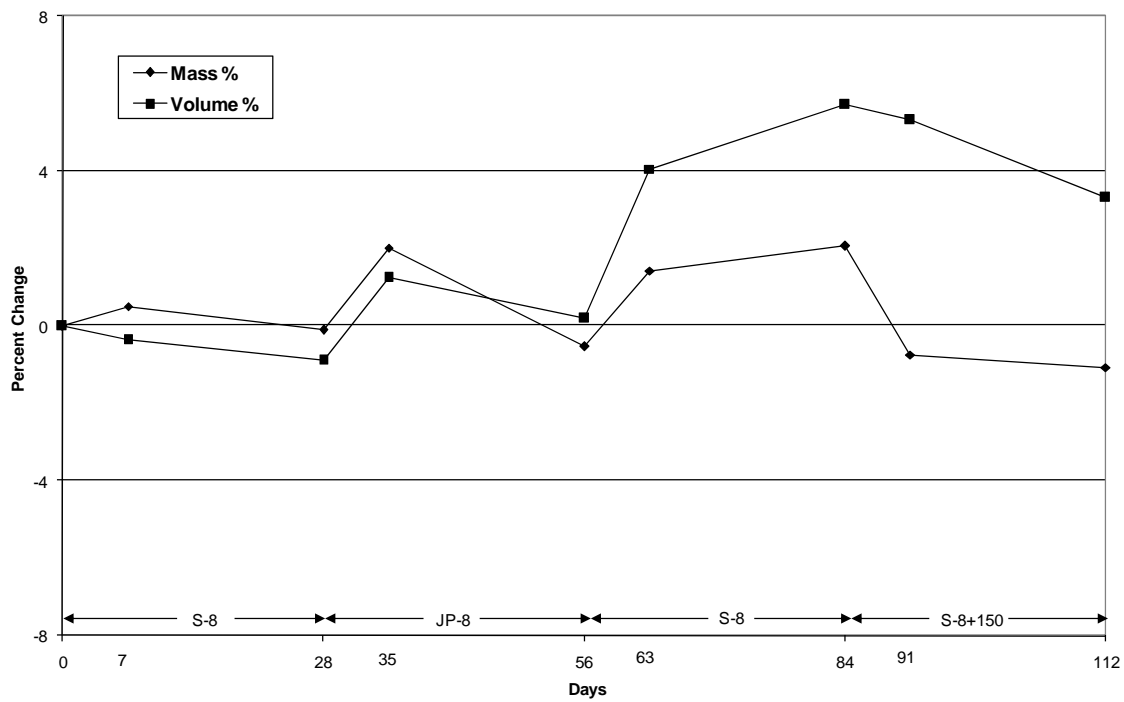
Stanadyne Pump Used Viton Head & Rotor Assembly O-Ring in Fuel P-2-1



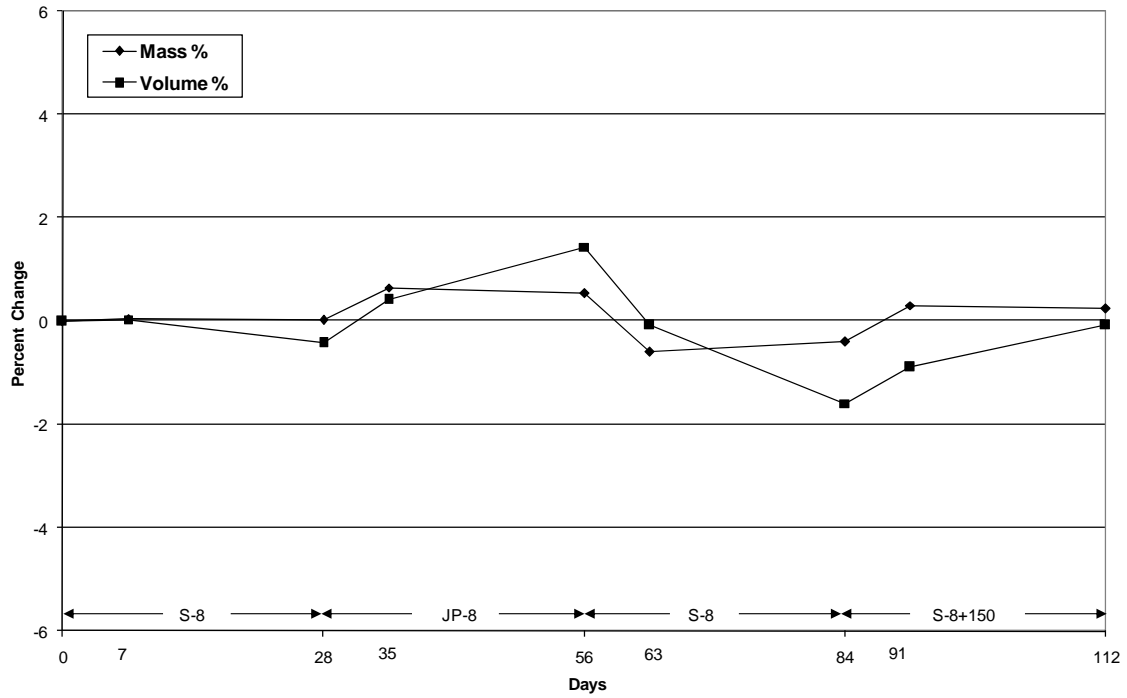
Stanadyne Pump Used Transfer Pump Viton O-Ring in fuel P-2-2



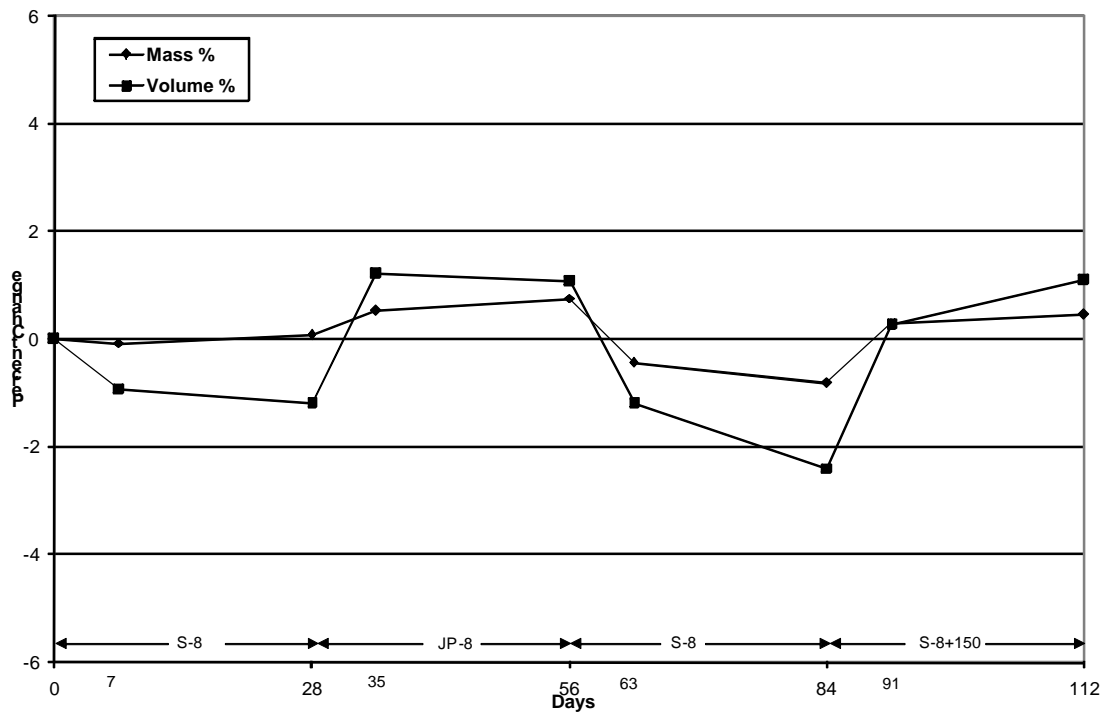
Stanadyne Pump Used Red Fluorosilicone Shaft Seal in Fuel P-2-3



Stanadyne Pump Used Black Viton Shaft Seal in Fuel P-2-4

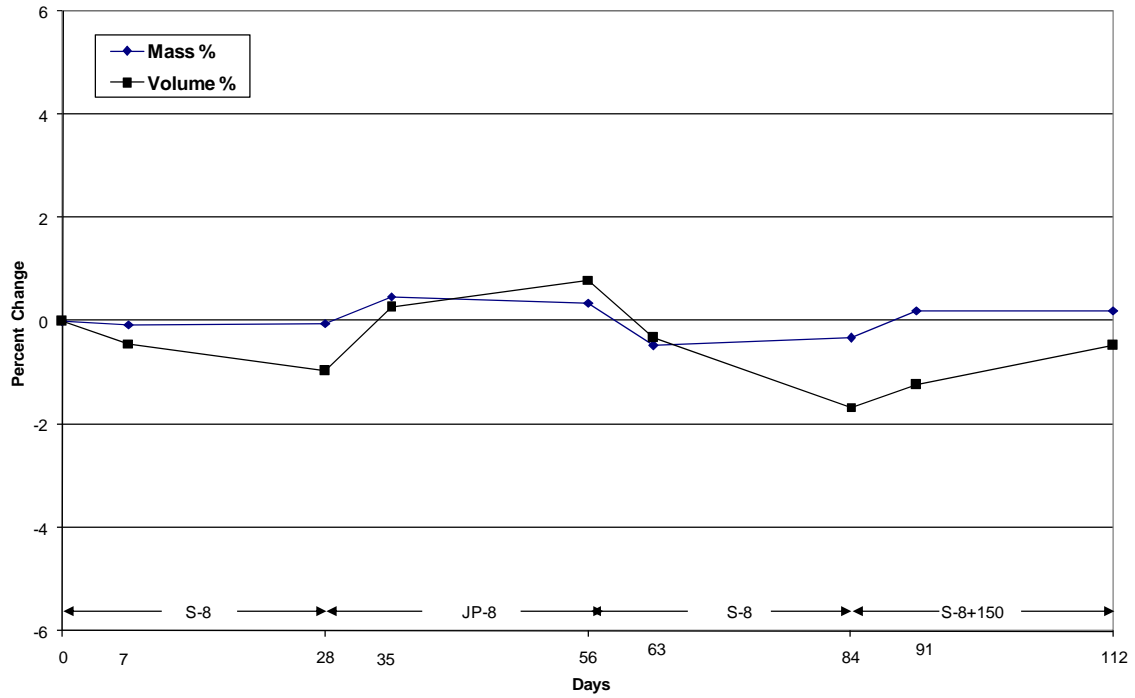


Stanadyne Pump Used Viton Governor Stud Guide Ring in Fuel P2-5

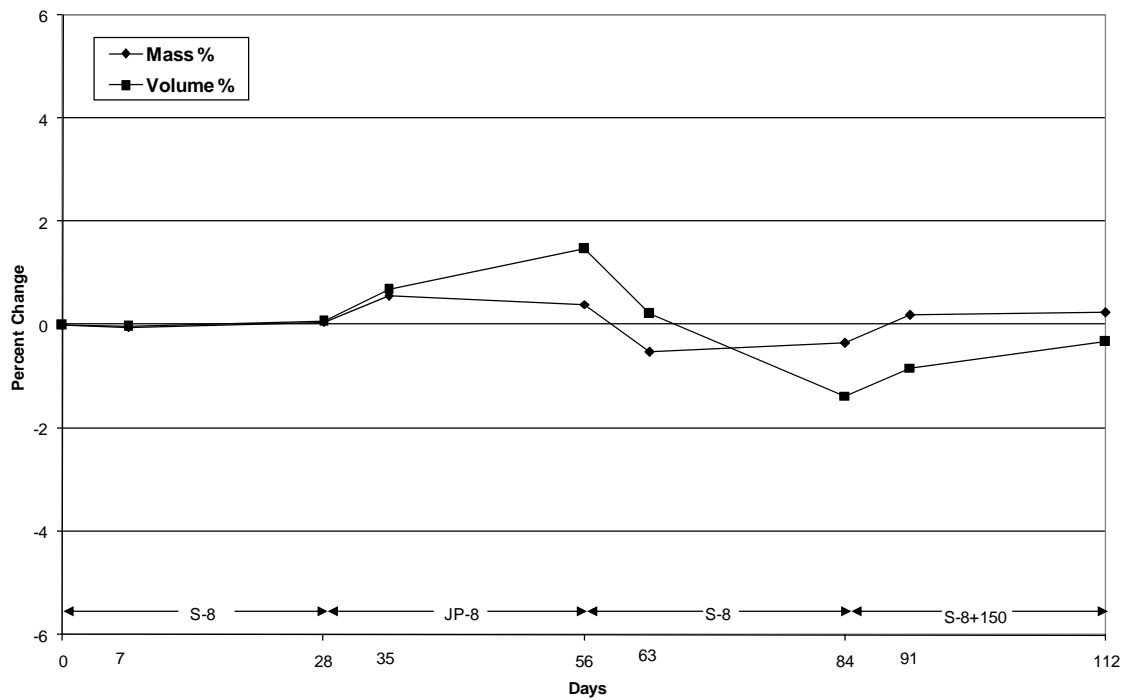


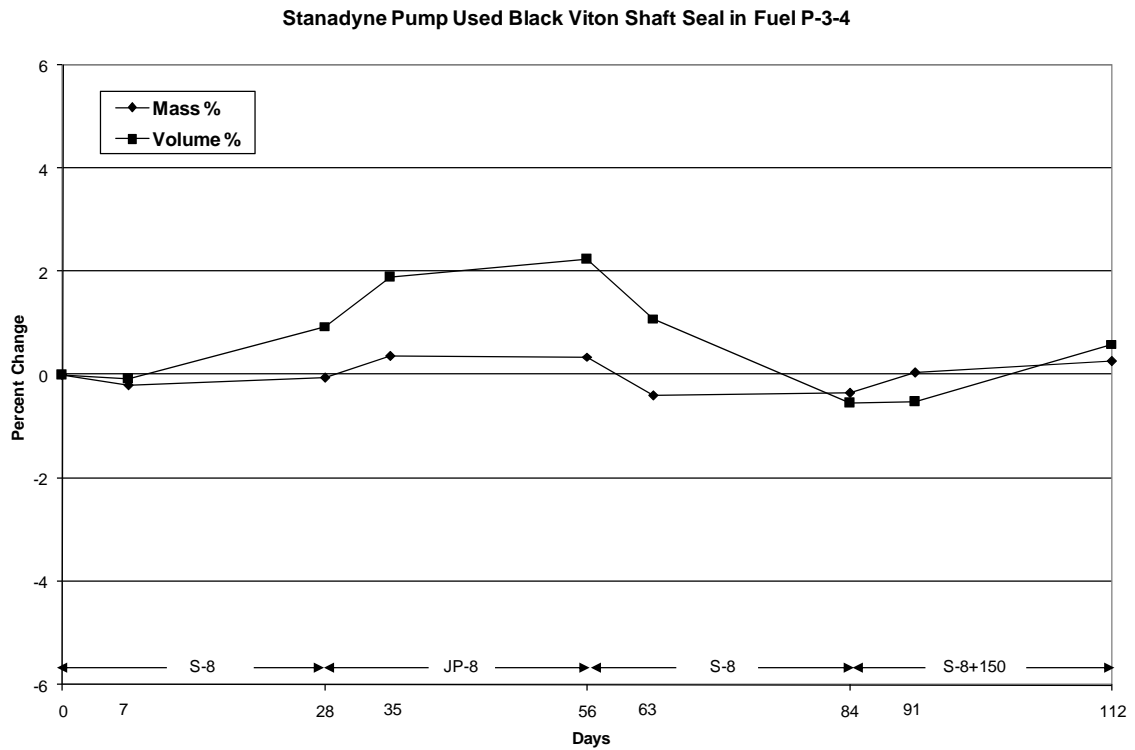
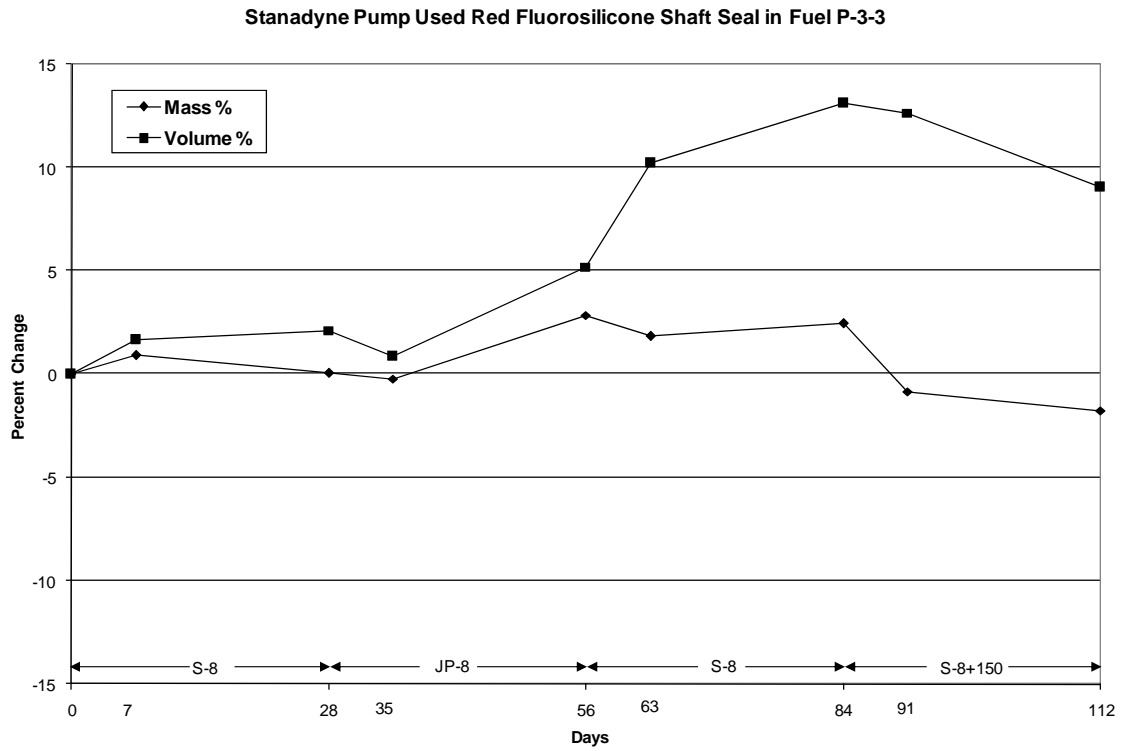


Stanadyne Pump Used Viton Head & Rotor Assembly 0-Ring in Fuel P-3-1

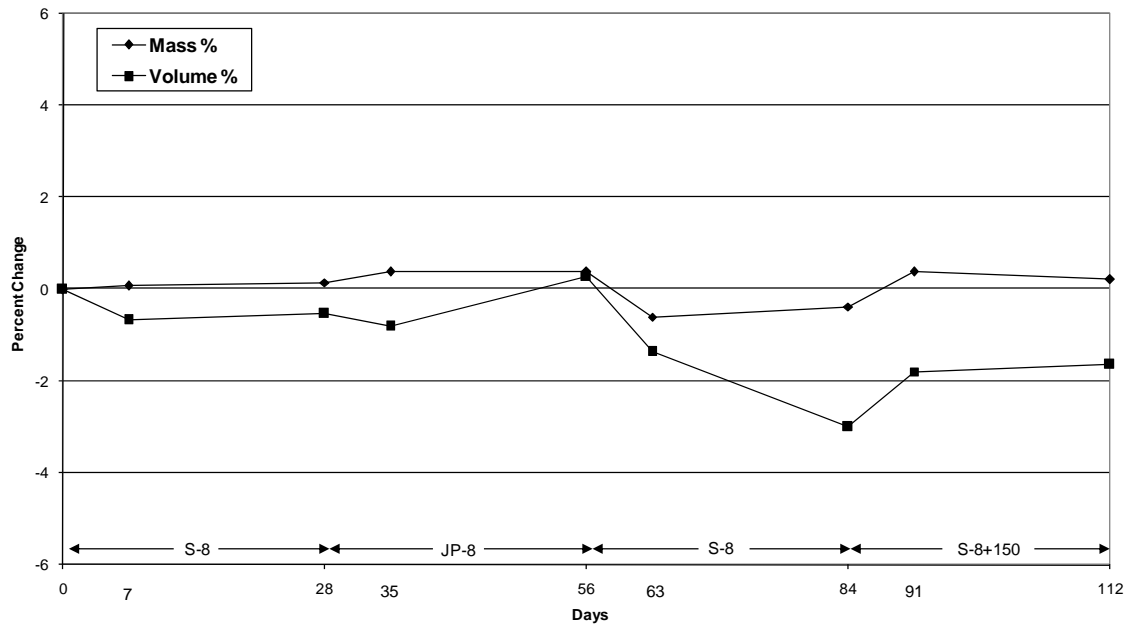


Stanadyne Pump Used Transfer Pump Viton 0-Ring in fuel P-3-2





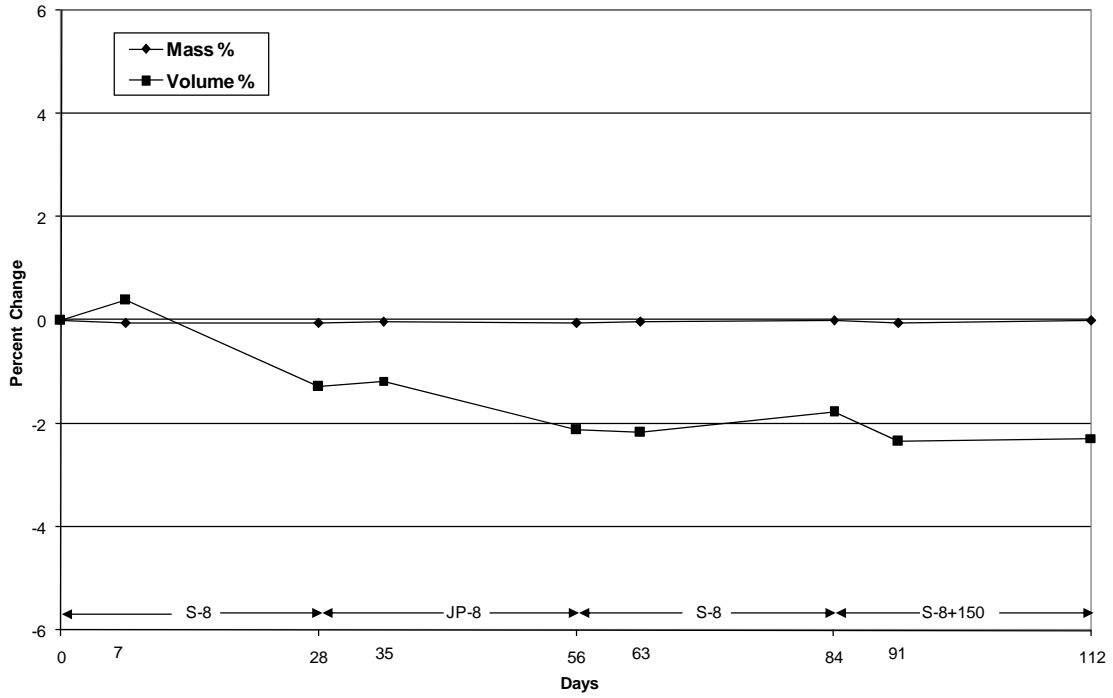
Stanadyne Pump Used Viton Governor Stud Guide O-Ring in Fuel P-3-5



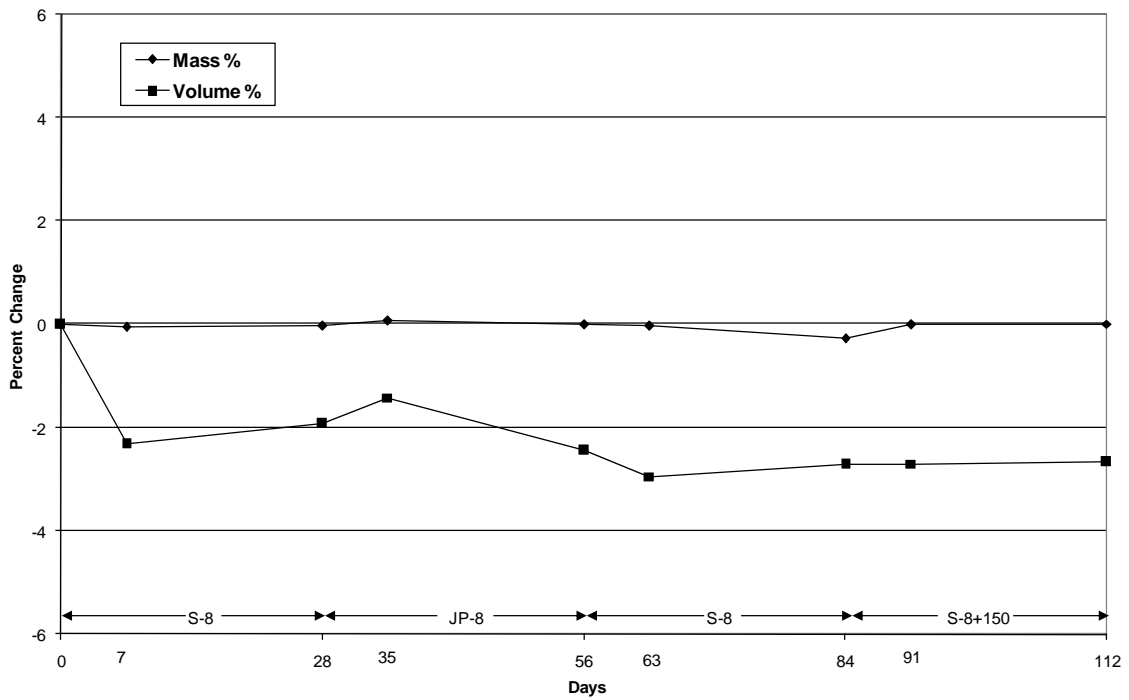
## **APPENDIX II-C**

**Bosch Pump  
Data for Individual Elastomers  
Change Calculated by Method A (Cumulative)**

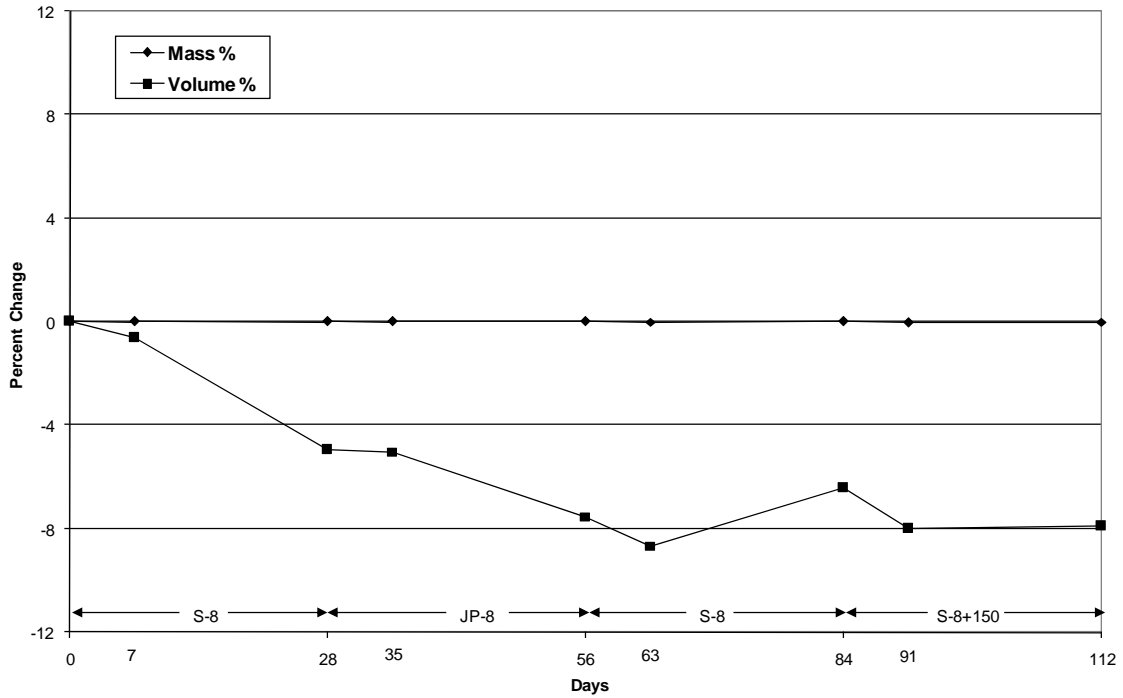
Bosch Pump Butadiene Barrel Assembly O-Ring (Black) New in Air NA-2



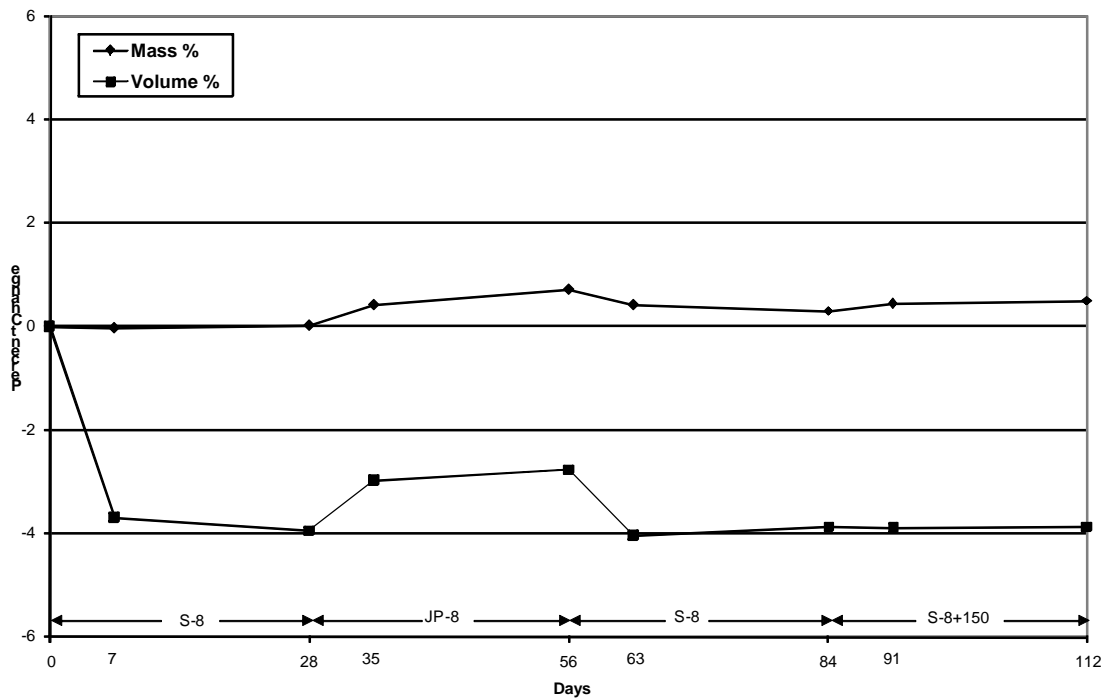
Bosch Pump Butadiene Barrel Assembly O-Ring (Green) New in Air NA-3



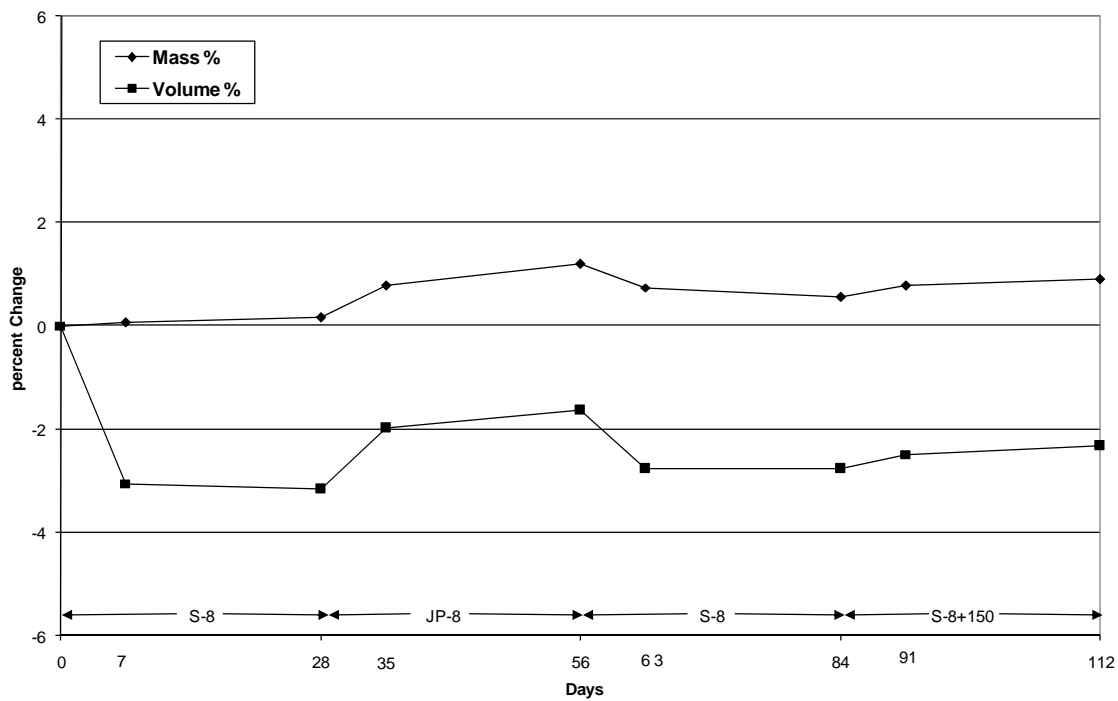
Bosch Pump Nitrile Fuel Gallery Seal / Washer New in Air NA-4



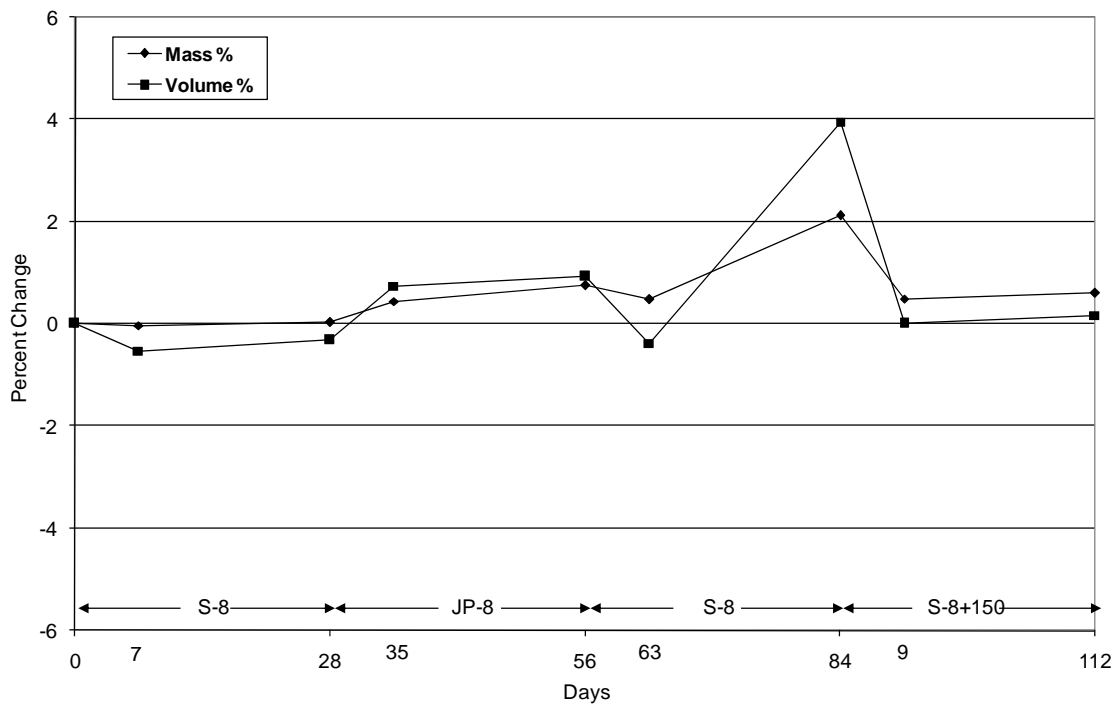
Bosch Pump Butadiene Delivery Valve Assembly-Ring (Green) New in Fuel NF1



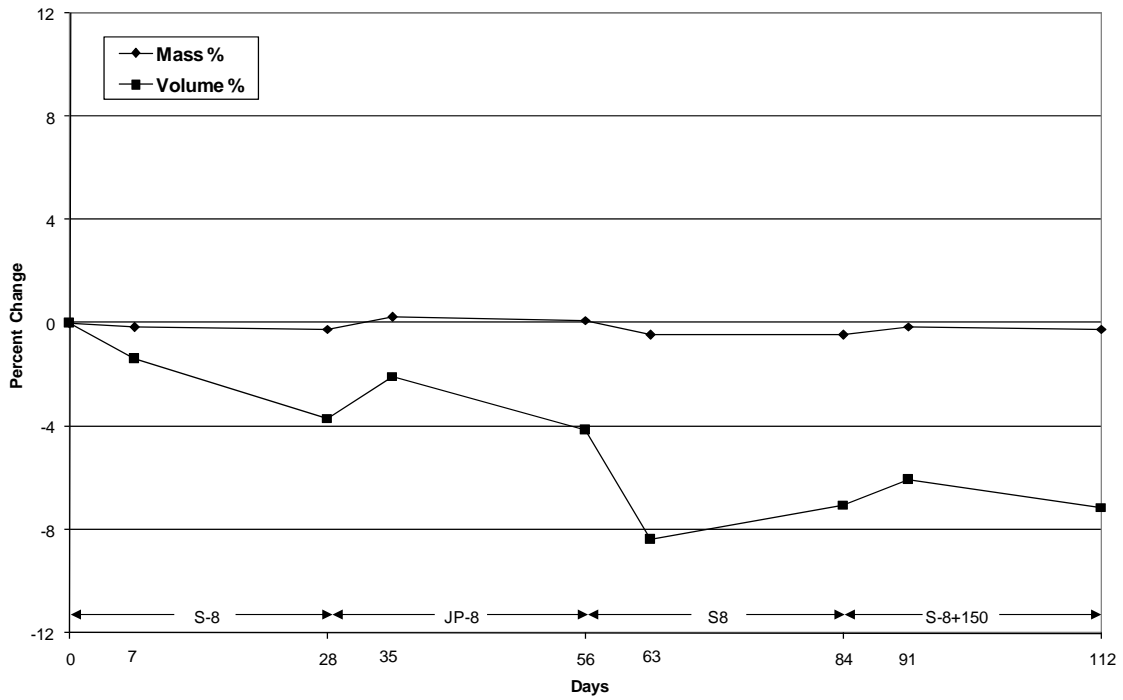
Bosch Pump Butadiene Barrel Assembly O-Ring (Black) New in Fuel NF-2



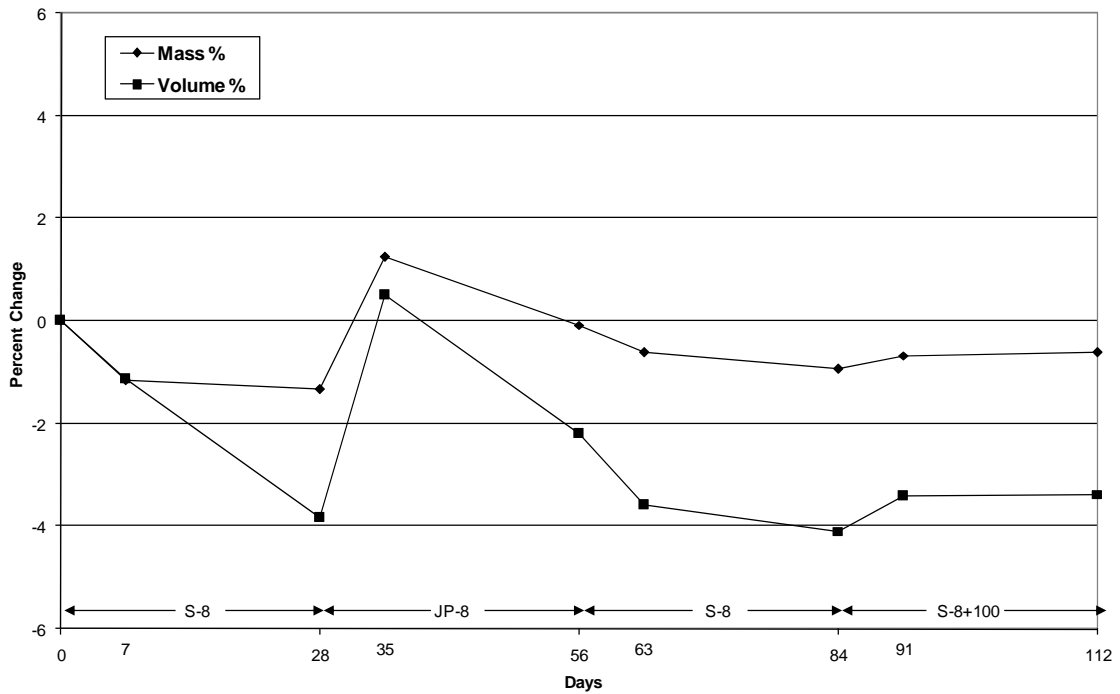
Bosch Pump Butadiene Barrel Assembly O-Ring (Green) New in Fuel NF-3



Bosch Pump Nitrile Fuel Gallery Seal/Washer New in Fuel NF-4

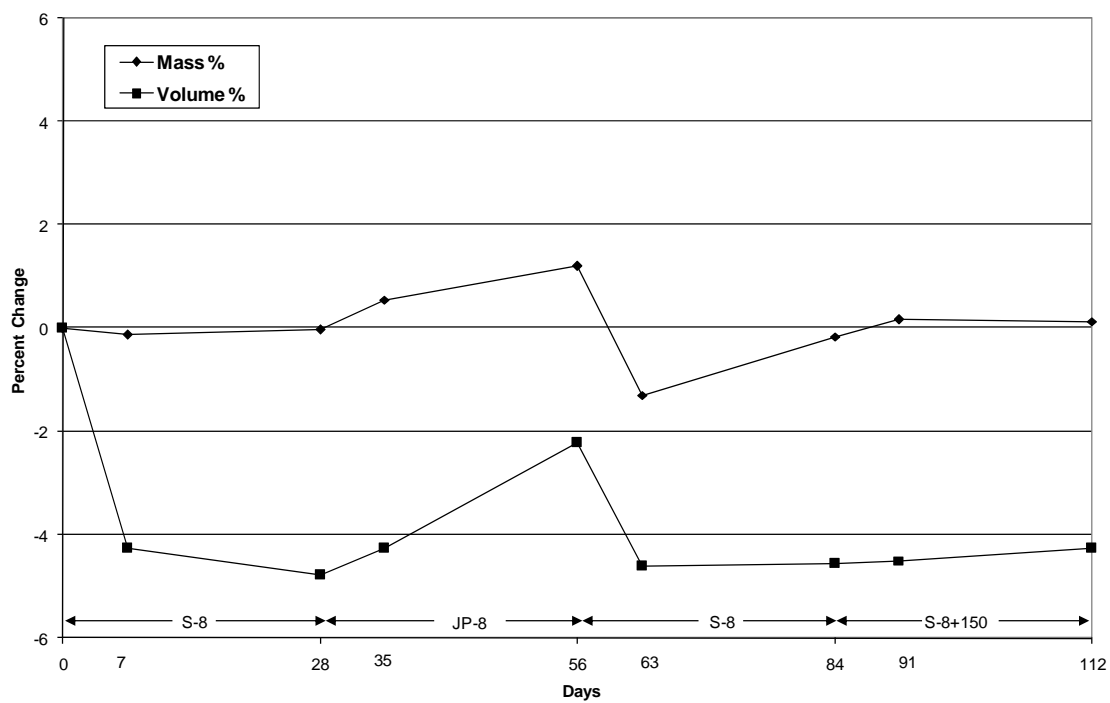


Bosch Pump Butadiene Delivery Valve Assembly O-Ring (Green) Used in Fuel P-1-1

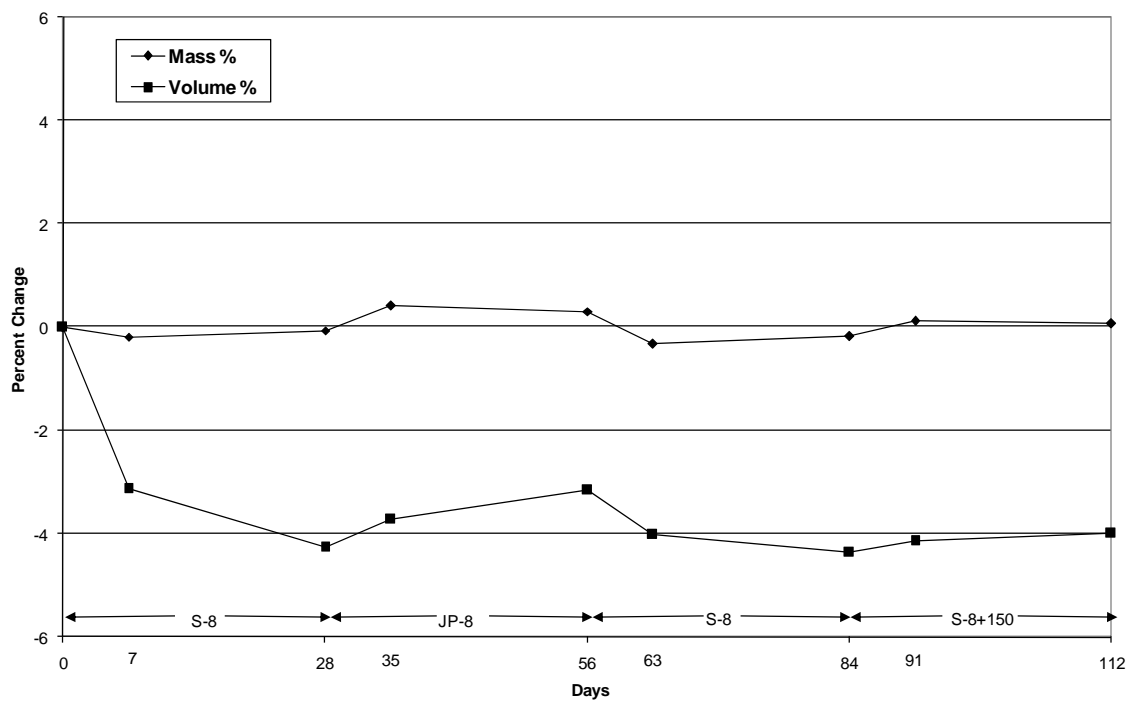




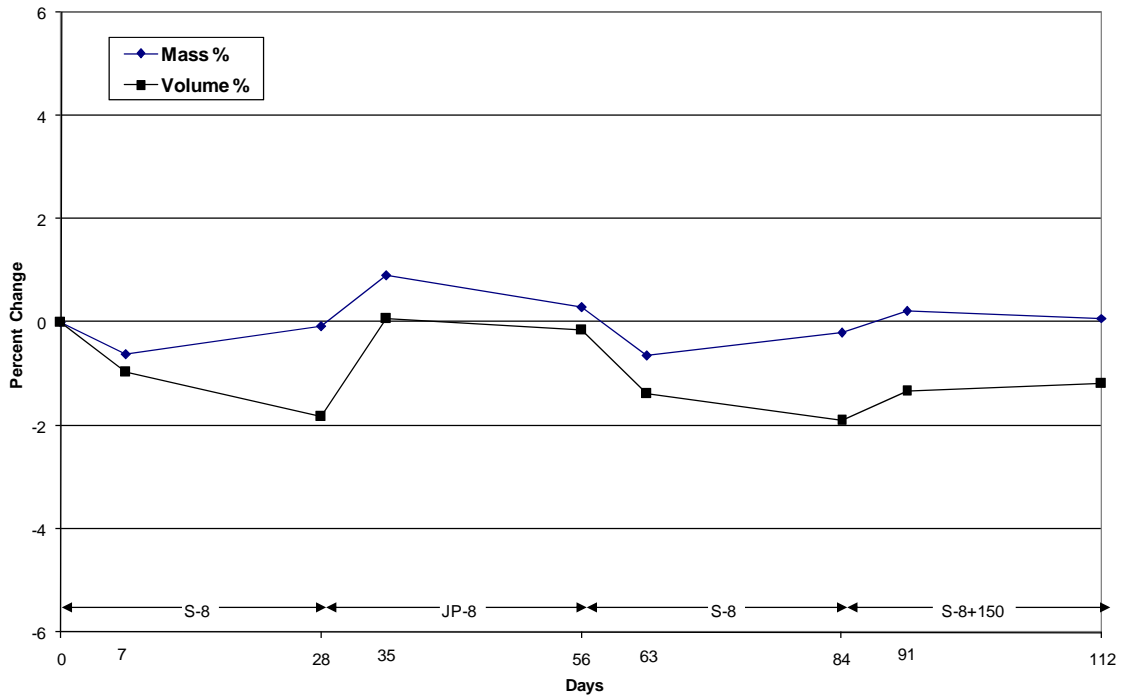
Bosch Pump Butadiene Barrel Assembly O-Ring (Black) Used in Fuel P-1-2



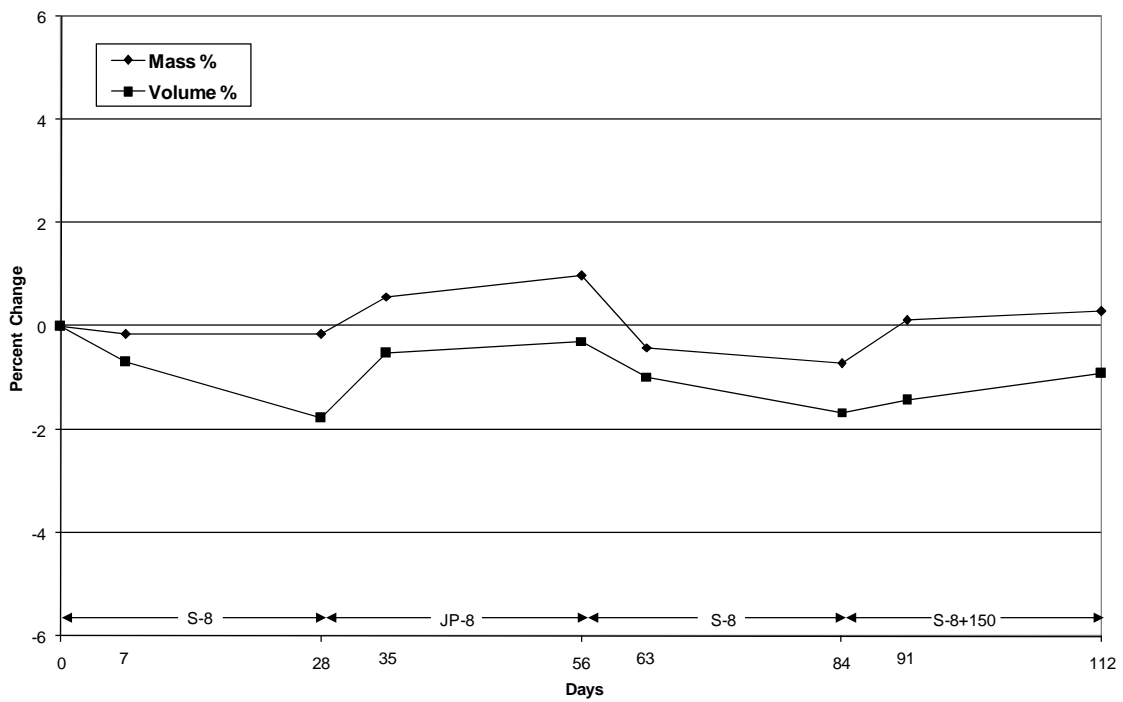
Bosch Pump Butadiene Barrel Assembly O-Ring (Green) Used in Fuel P-1-3



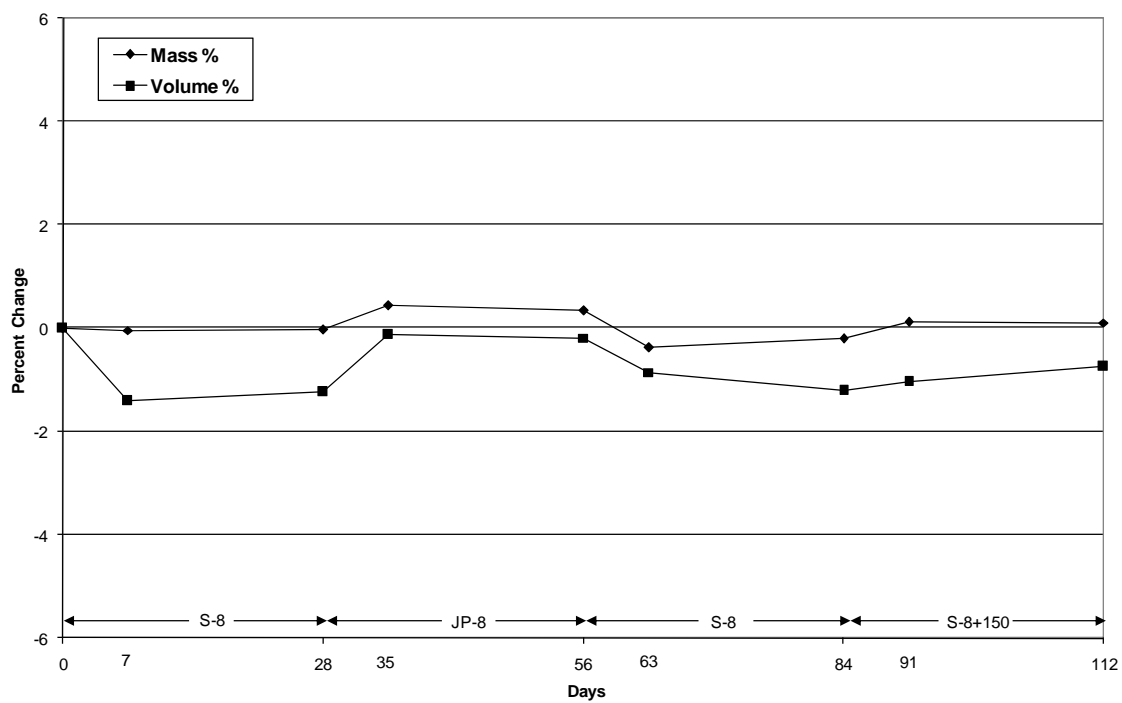
Bosch Pump Butadiene Delivery Valve Assembly O-Ring (Green) Used in Fuel P-2-1



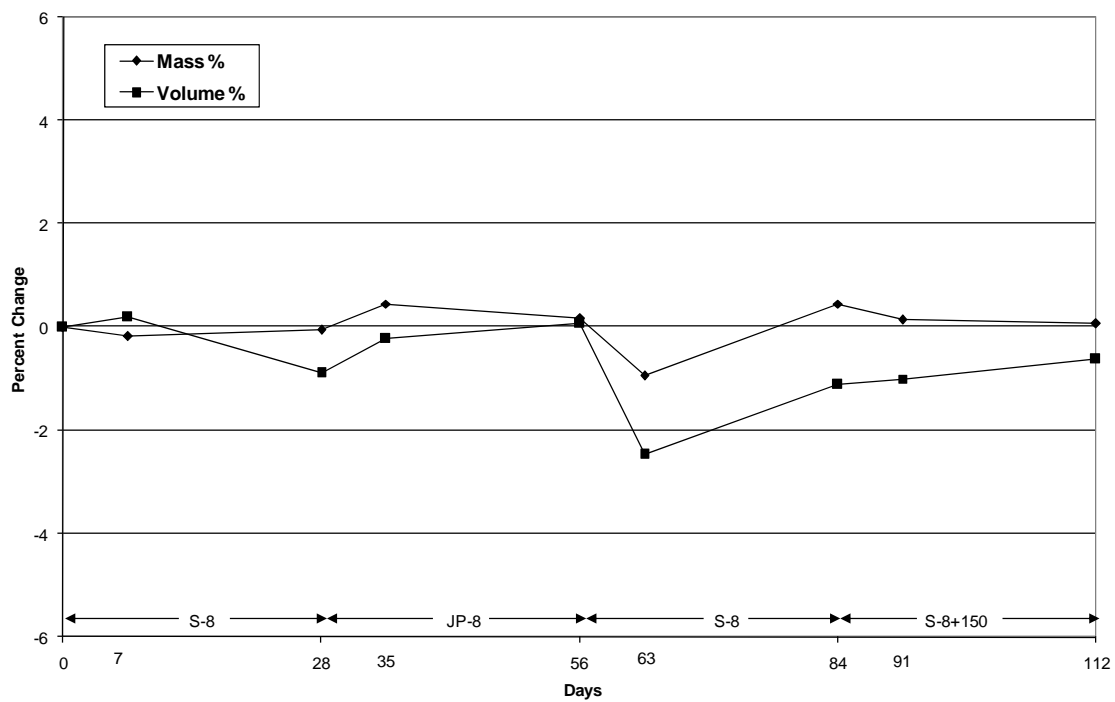
Bosch Pump Butadiene Barrel Assembly O-Ring (Black) Used in Fuel P-2-2



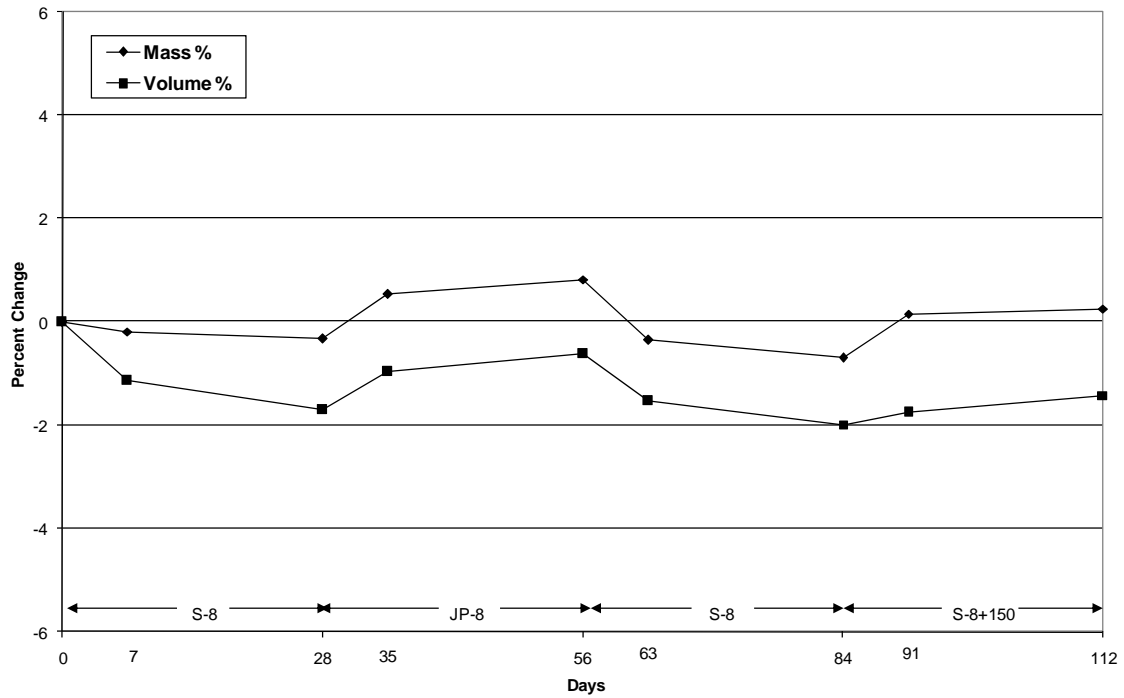
Bosch Pump Butadiene Barrel Assembly O-Ring (Black) Used in Fuel P-2-3



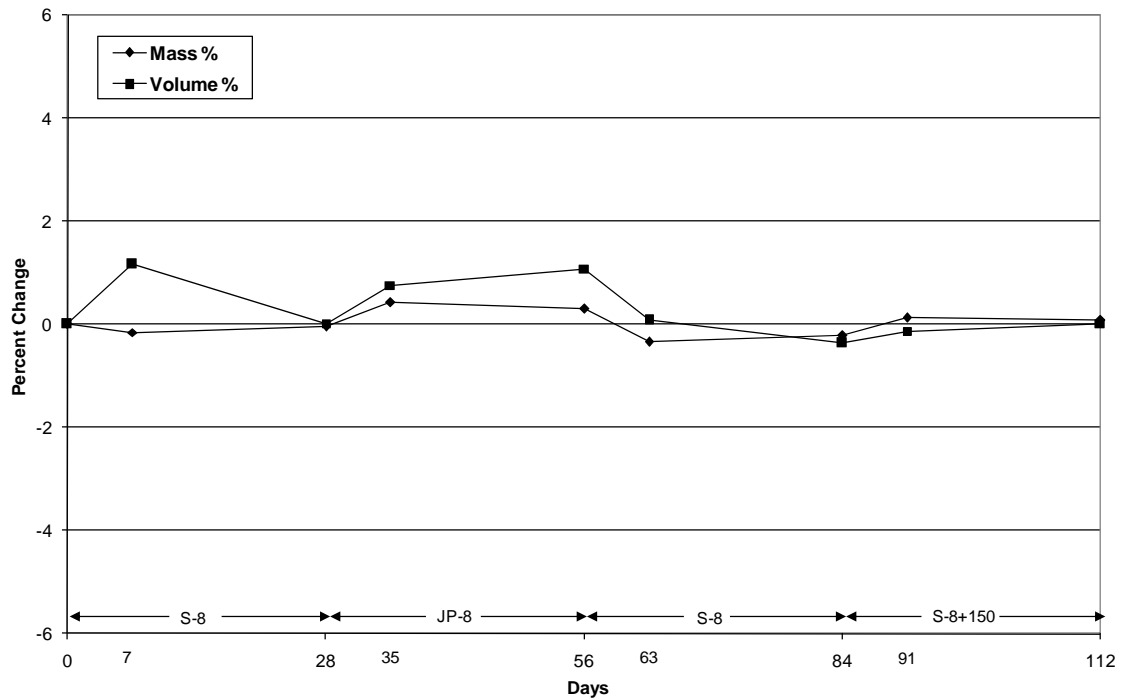
Bosch Pump Butadiene Delivery Valve Assembly O-Ring (Green) Used in Fuel P-3-1



Bosch Pump Butadiene Barrel Assembly O-Ring (Black) Used in Fuel P-3-2



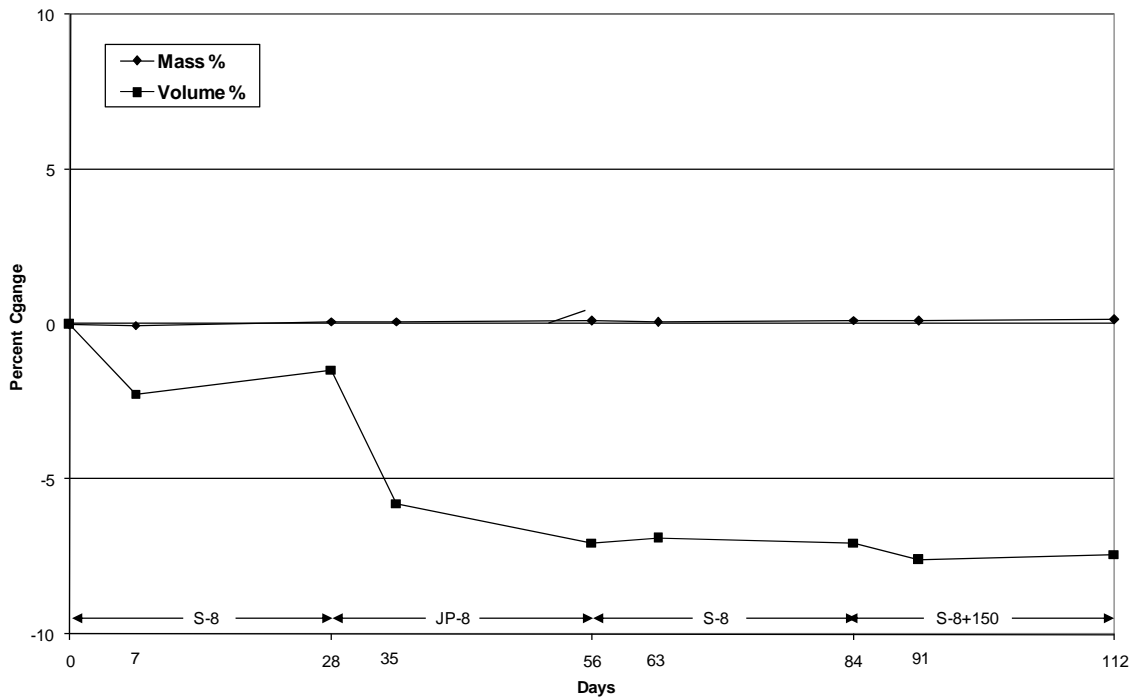
Bosch Pump Butadiene Barrel Assembly O-Ring (Black) Used in Fuel P-3-3



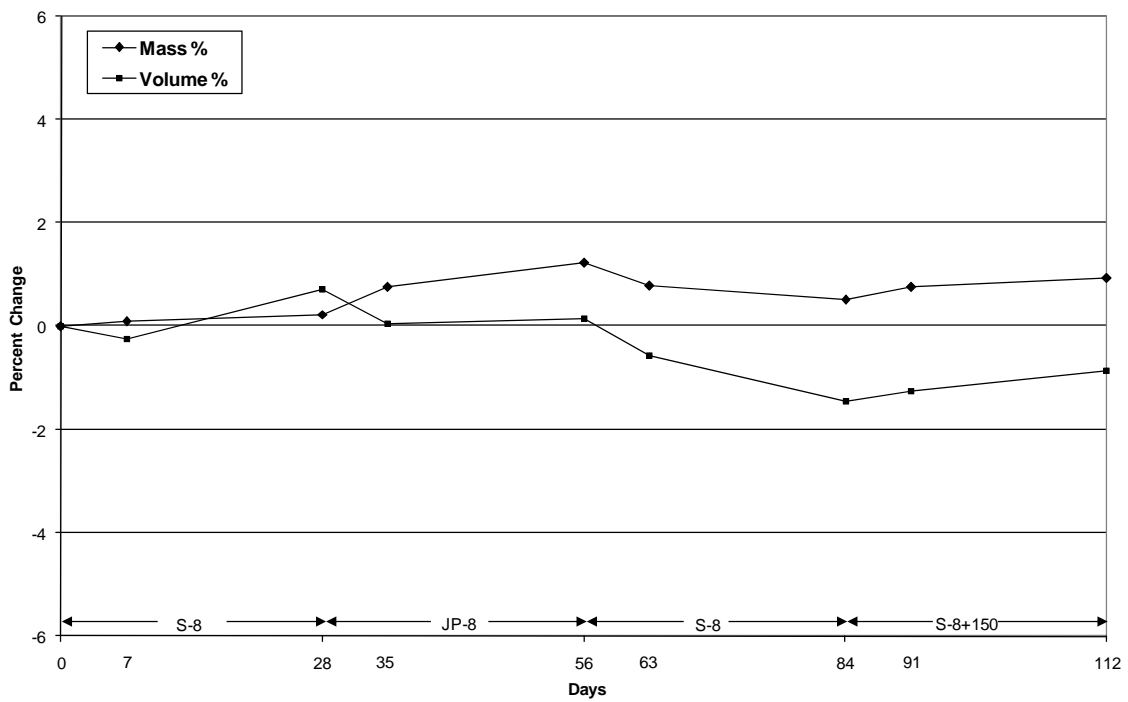
## **APPENDIX II-D**

**Detroit Diesel Unit Injector  
Data for Individual Elastomers  
Change Calculated by Method A (Cumulative)**

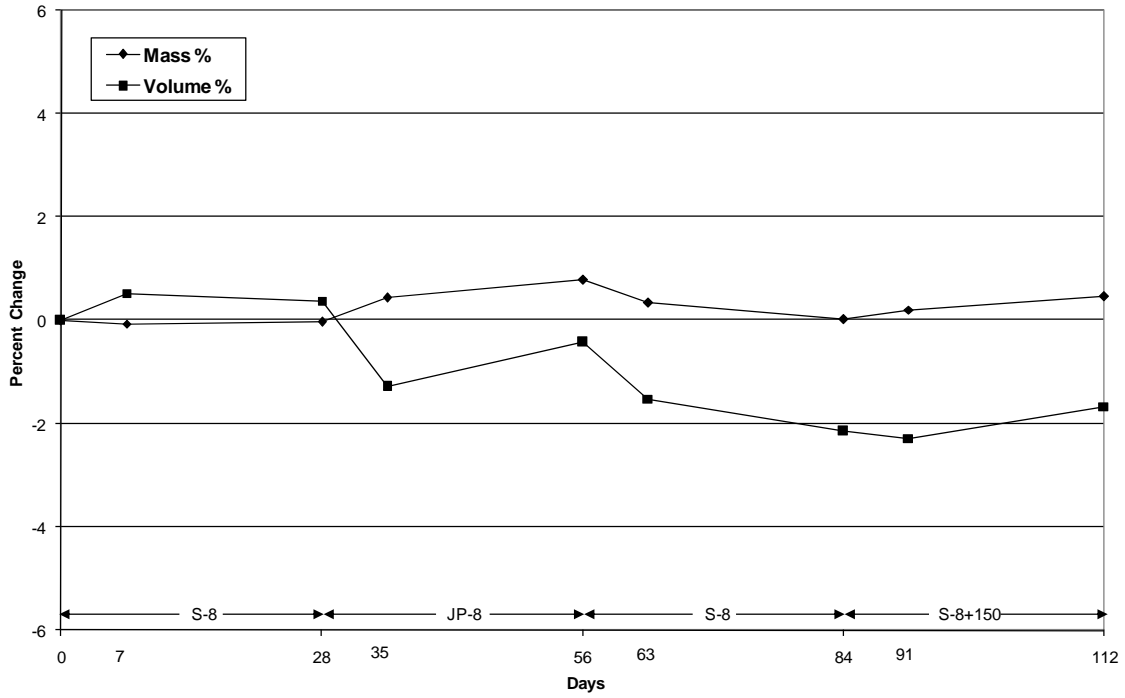
Detroit Diesel Injector Viton O-Ring New In Air NA1



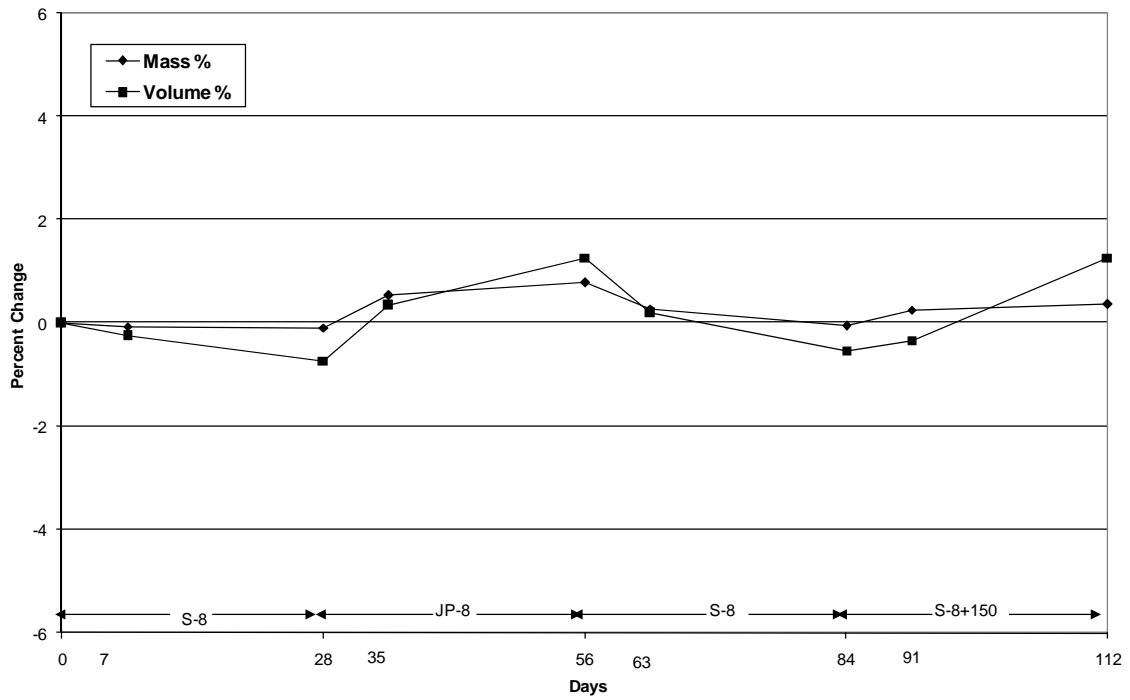
Detroit Diesel Injector Viton O-Ring New in Fuel NF-1



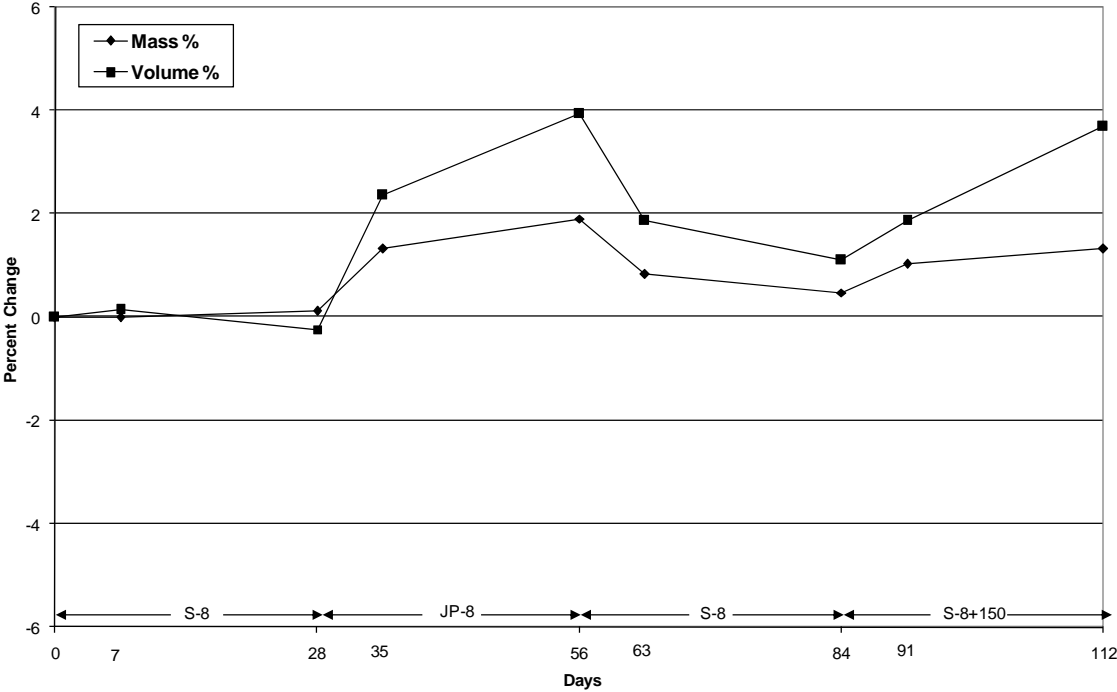
Detroit Diesel Injector Viton O-Ring Used in Fuel D U-1



Detroit Diesel Injector Viton O-Ring Used in Fuel D U-2



Detroit Diesel Injector Viton O-Ring Used in Fuel D U-3





## **APPENDIX IV-A**

### **Injection Pump Elastomer Identification Table**

INJECTION PUMP ELASTOMER IDENTIFICATION TABLE

Equipment Nomenclature	Engine Manufacturer & Model Number	Injection System Manufacturer	Injection System Type	Seal/Gasket Nomenclature	NSN	Part No.	Elastomer Composition	Technical Manual Number.
Fighting Vehicle M2B, 5 Ton M939/A1 Series Truck	Cummins VTA 903T Cummins NHC 250	Cummins	Pressure Timed	Gasket Set (Kit)	5330-00-432-3813	3010240	N/A	TM 9-2320-272-24P
				O-ring, Throttle Shaft	5330-00-081-9289	100478	Rubber, Synthetic	TM 9-2320-272-24P
				O-ring, Fuel Damper	5330-00-809-2667	100099	Rubber, Synthetic	TM 9-2320-272-24P
				O-ring, Fuel Damper	5330-00-809-3276	139888	Rubber, Synthetic	TM 9-2320-272-24P
				Gear Pump Gasket	5330-01-136-8569	3069017	Rubber, Synthetic	TM 9-2320-272-24P
Recovery Vehicle M88A1/2, Combat Engineer Vehicle M728, Bridge Launcher M60 Tank	Continental AVDS1790-2DR Continental AVDS1790-2D Continental AVDS 1790-2D	AMBAC	PSB-12BT Rotary	Gasket Set (Kit)	5330-00-786-6239	5702632	N/A	TM 9-2910-212-34&P
				O-ring, Fuel Return Housing	5330-00-679-3166	MS28775-116	Butadiene-Acrylonitrile	TM 9-2910-212-34&P
				O-ring, Fuel Inlet Housing	5331-00-819-8111	MS28778-24	Butadiene-Acrylonitrile	TM 9-2910-212-34&P
				Gasket, Solenoid Cover	5330-00-786-0190	GA8814	Buna N Nitrile	TM 9-2910-212-34&P
				Gasket, Fuel Shut-Off Lever	5330-00-310-4659	GA401346	Buna N Nitrile	TM 9-2910-212-34&P
				Gasket, Shaft Lever	5330-00-583-3473	GA1144	Buna N Nitrile	TM 9-2910-212-34&P
				Gasket, Connector Recepticle	5330-00-627-0635	7383426	Buna N Nitrile	TM 9-2910-212-34&P
				Gasket, Governor Cover	5330-00-310-4556	GA908	Buna N Nitrile	TM 9-2910-212-34&P
				Gasket, Governor Housing	5330-01-507-0760	GA8813	Buna N Nitrile	TM 9-2910-212-34&P
				Gasket, Governor Cap	5330-00-440-9687	GA902	Buna N Nitrile	TM 9-2910-212-34&P
				Gasket, Operating Shaft Plate	5330-00-406-7316	GA9031	Buna N Nitrile	TM 9-2910-212-34&P
				O-ring, Head Assembly	5331-00-408-4432	MS28775-237	Butadiene-Acrylonitrile	TM 9-2910-212-34&P
				O-ring, Head Assembly	5331-00-676-9733	MS28775-234	Butadiene-Acrylonitrile	TM 9-2910-212-34&P
				O-ring, Head Assembly	5331-01-287-4813	MS28775-230	Butadiene-Acrylonitrile	TM 9-2910-212-34&P
				O-ring, Quill Shaft Plug	5331-00-684-0263	MS28775-218	Butadiene-Acrylonitrile	TM 9-2910-212-34&P
				O-ring, Control Unit	5330-00-418-1920	MS28775-017	Butadiene-Acrylonitrile	TM 9-2910-212-34&P
				Gasket, Plunger Bore Screw	5330-01-433-8436	GA10164	Buna N Nitrile	TM 9-2910-212-34&P
				Gasket, Delivery	5330-01-433-8434	GA9035	Buna N Nitrile	TM 9-2910-212-34&P
Stryker Light Armored Veh, LMTV, MTV 2.5 and 5 Ton	Caterpillar 3116 and 3126B	Caterpillar	Unit Injector	Injector O-ring	5331-01-066-0673	1P8116	Viton	TM 9-2320-366-24P-1
				Injector O-ring	5331-01-360-4012	125-8274	Viton	TM 9-2320-366-24P-1
HMMWV Series Trucks	GM 6.2L & 6.5L	Stanadyne	DB2829-4879 Rotary	Gasket Set (Kit)	2910-01-299-0473	30405	N/A	TM 9-2815-237-34P
				Seal, Driveshaft	5331-01-336-9559	10453	Viton	TM 9-2815-237-34P
				Seal, Driveshaft (Red)	5330-01-192-6779	21860	Fluorosilicone	TM 9-2815-237-34P
				Gasket, Timing Window Cover	5330-01-233-2848	27603	Viton	TM 9-2815-237-34P
				Seal, O ring, Hydraulic Head	5330-01-236-0475	27245	Viton	TM 9-2815-237-34P
				Seal, O ring, Plate Lock	5330-01-236-0476	27601	Viton	TM 9-2815-237-34P
				Seal, Transfer Pump	5330-01-236-0474	27608	Viton	TM 9-2815-237-34P
				Seal, O ring, Gov Adj Screw	5331-00-441-8283	11507	BUNA N Nitrile	TM 9-2815-237-34P
				Seal, Throttle Shaft Control	5331-01-215-9638	24585	Viton	TM 9-2815-237-34P
				Seal, O ring, Drain Plug	5330-01-233-2778	27609	Viton	TM 9-2815-237-34P
				Seal, O ring, Cam Advance	5331-01-2327-7886	27610	Viton	TM 9-2815-237-34P
				Seal, Advance Plunger	5330-01-233-8597	27163	Viton	TM 9-2815-237-34P
				Seal, O ring, Screw Head Locating	5330-01-236-0472	27602	Viton	TM 9-2815-237-34P
				Seal, O ring, Hsg Press Reg Assy		27607	Viton	TM 9-2815-237-34P
				Seal, Access Cover	5330-01-234-2615	27244	Viton	TM 9-2815-237-34P
M939A2 Series 5 Ton Truck	Cummins 6 CTA 8.3L	Bosch	Six Cylinder In Line	Gasket Set (Kit)	2910-01-339-7912	1417010008	N/A	TM 9-2320-272-24P-1
				Seal, O ring, Barrel Assembly	5331-01-301-6992	1410210603	Butadiene	TM 9-2320-272-24P-1
				Seal, O ring, Barrel Assembly	5331-01301-7887	1410210601	Butadiene	TM 9-2320-272-24P-1
				Seal, O ring, Delivery Valve	5331-01-303-1635	1410210041	Butadiene	TM 9-2320-272-24P-1
				Seal/Washer, Fuel Galley	5330-12-156-4523	7603014106	BUNA N Nitrile	TM 9-2320-272-24P-1
Truck, 10 Ton HMMTT	Detroit Diesel 8V92T	Detroit Diesel	Unit Injector	Seal, O ring, Fuel System	5330-01-308-5923	5234281	Viton	TM 9-2320-279-24P-1
Combat Earthmover DEUCE	Caterpillar 3126 HEUI	Caterpillar	Unit Injector	Seal, O ring, Fuel System	5330-01-348-2720	1148718	Viton	TM 5-2430-200-24P
Container Handler RT 240 53K	Cummins QSM-11	Cummins	Pressure Timed	Seal, O ring, Housing Actuator	5331-00-081-8299	129888	Rubber, Synthetic	TM 10-3930-675-24P
				Gasket, Pump Mounting	5330-01-338-4829	3069103	Rubber, Synthetic	TM 10-3930-675-24P
Generator Set 100KW	Caterpillar 3306T	Caterpillar	Cam Actuated In-Line	Gasket Set (Kit)	5330-00-132-5996	5P8766	N/A	TM 5-6115-600-24P
				O-ring, Priming Pump	5330-00-591-7543	7F8607	Viton	TM 5-6115-600-24P
				O-Ring, Fuel Valve	5330-01-198-6169	5B3718	Viton	TM 5-6115-600-24P
				Packing, w/ Retainer	5330-00-333-4032	1634594	Viton	TM 5-6115-600-24P

Generator Set 60KW, Truck Forklift RT 10K	John Deere 6059T	Stanadyne	DB4627-4807 Rotary	Gasket Set (Kit)	5330-01-333-5398	24372	N/A	TM 9-2815-266-24P
				Seal, O-Ring, Connector Assy	5331-01-480-8865	27607	Viton	TM 9-2815-266-24P
				Seal, O-Ring, Throttle Shaft	5331-01-309-9370	17438	Viton	TM 9-2815-266-24P
				Gasket, Cover Access	5330-01-234-2615	27244	Viton	TM 9-2815-266-24P
				Seal, O-Ring, Screw	5331-01-236-0472	27602	Viton	TM 9-2815-266-24P
				Seal, O-Ring, Screw, Cam Adv	5331-01-232-7886	27610	Viton	TM 9-2815-266-24P
				Seal, O-Ring, Adv Plug	5331-01-399-2159	29280	Viton	TM 9-2815-266-24P
				Retainer, Packing, Piston Ring	5330-01-399-2161	29281	Viton	TM 9-2815-266-24P
				Seal, O-Ring, Adv Plug	5331-01-399-2160	29282	Viton	TM 9-2815-266-24P
				Seal, O-Ring, Pivot Shaft	5331-01-423-4023	31332	Viton	TM 9-2815-266-24P
				Gasket, Timing Window	5330-01-233-2848	27603	Viton	TM 9-2815-266-24P
				Tube, Insulating	4710-01-230-6611	23190	Viton	TM 9-2815-266-24P
				Spacer, Drive Shaft	5330-01-467-4053	30445	Nylon	TM 9-2815-266-24P
				Seal, Drive Shaft	5330-01-470-2039	30804	HPNP & Nitrile	TM 9-2815-266-24P
				Seal, O-Ring, Cap Assembly	5131-00-877-4960	12966	Viton	TM 9-2815-266-24P
				Seal, O-Ring Regulator	5331-01-236-0473	19844	Viton	TM 9-2815-266-24P
				Packing, Preformed	5330-01-236-0474	27608	Viton	TM 9-2815-266-24P
				Seal, O-Ring, Cntrl Rod Guide	5331-01236-0476	27601	Viton	TM 9-2815-266-24P
Generator Set 60 KW	Allis Chalmers 3500	Stanadyne	DCMFC829-2672 Rotary	Gasket Set (Kit)	5330-00-401-5247	16369	N/A	TM 9-6115-545-24P
				Gasket, Governor Cover	5330-01-234-2615	27244	Viton	TM 9-6115-545-24P
				Seal, O-Ring, Throttle Shaft	5331-01-309-9370	17438	Viton	TM 9-6115-545-24P
				Seal, O-Ring, Regulator Assy	5331-00-171-5641	12406	Butadiene-Acrylonitrile	TM 9-6115-545-24P
				Seal, O-Ring, Filter Element	5331-00-441-8283	11507	Buna N Nitrile SR	TM 9-6115-545-24P
				Seal, O-Ring Piston Assembly	5330-00-901-0749	17056	Viton	TM 9-6115-545-24P
				Seal, O-Ring, Cap Assembly	5331-00-877-4960	12966	Viton SR	TM 9-6115-545-24P
				Seal, O-Ring, Control Rod Guide	5331-00-937-8477	13550	Butadiene-Acrylonitrile	TM 9-6115-545-24P
				Seal, O-Ring, Shaft, Governor	5331-00-441-8286	11588	Rubber, Synthetic	TM 9-6115-545-24P
				Seal, O-Ring, Plug, Piston Hole	5331-01-014-6985	20113	Butadiene-Acrylonitrile	TM 9-6115-545-24P
				Seal, O-Ring, Plug, Piston Hole	5331-01-974-6643	12764	Rubber, Synthetic	TM 9-6115-545-24P
				Seal, O-Ring, Plug	5331-00-936-4587	12766	Butadiene-Acrylonitrile	TM 9-6115-545-24P
				Seal, O-Ring, Cam Ring	5331-00-441-8291	11304	Rubber, Synthetic	TM 9-6115-545-24P
				Gasket, Timing Window	5330-00-506-3975	10574	Nitrile (BUNA)	TM 9-6115-545-24P
				Seal, O-Ring, Drive Shaft Assy	5331-00-171-5641	12406	Butadiene-Acrylonitrile	TM 9-6115-545-24P
				Packing Preformed, Drive Sft Assy	5330-00-757-1680	10453	Viton	TM 9-6115-545-24P
Generator Set 30KW	John Deere 4039T	Stanadyne	DB2435-4806 Rotary	Gasket Set (Kit)	5330-01-236-0625	24373	N/A	TM 9-2815-266-24P
				Seal, O-Ring, Connector Assy	5331-01-480-8865	27607	Viton	TM 9-2815-266-24P
				Gasket, Cover	5330-01-234-2615	27244	Viton	TM 9-2815-266-24P
				Seal, O-Ring, Screw	5331-01-236-0472	27602	Viton	TM 9-2815-266-24P
				Seal, O-Ring, Screw, Cam Adv	5331-01-232-7886	27610	Viton	TM 9-2815-266-24P
				Retainer, Packing, Piston Ring	5330-01-399-2161	29281	Viton	TM 9-2815-266-24P
				Seal, O-Ring, Adv Plug	5331-01-399-2159	29280	Viton	TM 9-2815-266-24P
				Seal, O-Ring, Adv Plug	5331-01-399-2160	29282	Viton	TM 9-2815-266-24P
				Seal, O-Ring, Governor Shaft	5331-01-423-4023	31332	Viton	TM 9-2815-266-24P
				Seal, O-Ring, Cap Assembly	5131-00-877-4960	12966	Viton	TM 9-2815-266-24P
				Gasket, Timing Window	5330-01-233-2848	27603	Viton	TM 9-2815-266-24P
				Tube, Insulating	4710-01-230-6611	23190	Viton	TM 9-2815-266-24P
				Seal, Drive Shaft	5330-00-757-1680	10453	Viton	TM 9-2815-266-24P
				Seal, O-Ring Regulating Valve	5331-01-236-0473	19844	Viton	TM 9-2815-266-24P
				Seal, O-Ring, Hydraulic Head	5330-01-236-0474	27608	Viton	TM 9-2815-266-24P
				Seal, O-Ring, Hydraulic Head	5331-01-236-0475	27245	Viton	TM 9-2815-266-24P

Generator Set 30KW	Hercules D298ERX37	Stanadyne	DBMFC633-1LK Rotary	Gasket Set (Kit)	6330-00-401-6247		N/A	TM 9-4115-465-24P
				Gasket, Cover	5330-01-234-2615	27244	Viton	TM 9-4115-465-24P
				Tube, Insulating	4710-01-230-5611	23190	Viton	TM 9-4115-465-24P
				Seal, Throttle Shaft	5331-01-309-9370	17438	Viton	TM 9-4115-465-24P
				Seal, O-Ring, End Plate	5331-00-171-5641	12406	Nitrile (BUNA)	TM 9-4115-465-24P
				Seal, Filter Element	5310-00-898-4927	15627	Nitrile (BUNA)	TM 9-4115-465-24P
				Seal, O-Ring, Gov Adj Screw	5331-00-441-8283	11607	Buna N Nitrile	TM 9-4115-465-24P
				Seal, O-Ring, Plug, End Plate	5331-00-877-4960	12966	Viton	TM 9-4115-465-24P
				Seal, O-Ring Transfer Pump	5331-01-344-4225	26965	Nitrile (BUNA)	TM 9-4115-465-24P
				Seal, O-Ring, Pivot Shaft	5331-01-4223-4043	31332	Viton	TM 9-4115-465-24P
				Seal, O-Ring, Cntrl Rod Guide	5331-01-236-0476	27601	Viton	TM 9-4115-465-24P
				Seal, O-Ring, Adv Plug	5331-01-399-2160	29282	Viton	TM 9-4115-465-24P
				Seal, O-Ring, Adv Plug	5331-01-399-2159	29280	Viton	TM 9-4115-465-24P
				Seal, O-Ring, Cam Adj Screw	5330-01-399-2161	29281	Viton	TM 9-4115-465-24P
				Seal, O-Ring, Adjusting Plug	5331-00-936-4687	12765	Viton	TM 9-4115-465-24P
				Seal, O-Ring, Head Rotor Assy	5330-00-441-8292	27245	Viton	TM 9-4115-465-24P
				Washer, Flat, Screw	5330-01-333-2677	10484	Viton	TM 9-4115-465-24P
				Gasket, Cover Line	5330-00-606-3975	10574	Viton	TM 9-4115-465-24P
				Seal, O-Ring, Tube	5331-00-877-4972	10519	Viton	TM 9-4115-465-24P
				Seal, O-Ring, Drive Shaft	5330-00-767-1680	10453	Viton	TM 9-4115-465-24P
Fork Lift, 6,000 Variable Reach	Cummins 5.9L	Bosch VE	Rotary	Gasket Set (Kit)	5330-01-340-8461	146701059	N/A	TM 10-3930-660-24P
				Seal, O-Ring, Lever Control	5331-12-315-3154	1460210301	Butyl Rubber	TM 10-3930-660-24P
				Seal, O-Ring, Adjusting Screw	5331-01-297-8867	1460210319	Butyl Rubber	TM 10-3930-660-24P
				Seal, O-Ring, Shaft	5331-12-315-5152	1460210008	Butyl Rubber	TM 10-3930-660-24P
				Seal, O-Ring, Governor Shaft	5331-01-344-6262	1420210047	Butyl Rubber	TM 10-3930-660-24P
				Seal, Plain Encased, Drive Shaft	5330-01-344-8014	1460283307	Viton	TM 10-3930-660-24P
				Gasket, Screw, Slotted Shldr	5330-01-344-8029	1460105307	Butyl Rubber	TM 10-3930-660-24P
				Seal, O-Ring, Plate Cover	5331-01-298-3058	1460210304	Butyl Rubber	TM 10-3930-660-24P
				Seal, O-Ring, Valve Control	5331-01-286-2491	1460210007	Butyl Rubber	TM 10-3930-660-24P
				Seal, O-Ring, Hydraulic Head	5331-01-286-7124	1900210164	Butyl Rubber	TM 10-3930-660-24P
				Seal, O-Ring, Electro Magnet	5331-01-201-4605	1460210006	Butyl Rubber	TM 10-3930-660-24P
				Seal, O-Ring, Plug Screw	5331-01-286-0801	1460210316	Butyl Rubber	TM 10-3930-660-24P
Fork Lift, 4,000 Rough Terrain	Cummins 4B 3.9L	Delphi	Rotary	Gasket Set (Kit)	2910-01-360-2406	7135-112	N/A	TM 10-3930-664-24P
				Gasket, Pump Cover	5330-00-085-2170	7123-287	Viton	TM 10-3930-664-24P
				O ring, Governor Shaft	5330-01-200-4703	5855-30	Viton	TM 10-3930-664-24P
				Gasket, Cover Access	5330-01-285-4908	9045-137	Viton	TM 10-3930-664-24P
				Gasket, Fuel Control Cover	5330-00-086-2754	7123-937	Viton	TM 10-3930-664-24P
				O ring, Electric Solenoid	5331-01-360-2841	5855-30DT	Viton	TM 10-3930-664-24P
				O ring, Hydraulic Head Rotor	5330-00-086-2725	7139-43	Viton	TM 10-3930-664-24P

## **APPENDIX IV-B**

### **Schematic Drawings Showing Location of Elastomers within the Pump**

**PUMP, FUEL METERING AND DISTRIBUTING  
AMERICAN BOSCH MODEL PSB-12BT**

**M88 RECOVERY VEHICLE**

**M60 AVLB BRIDGE LAUNCHER**

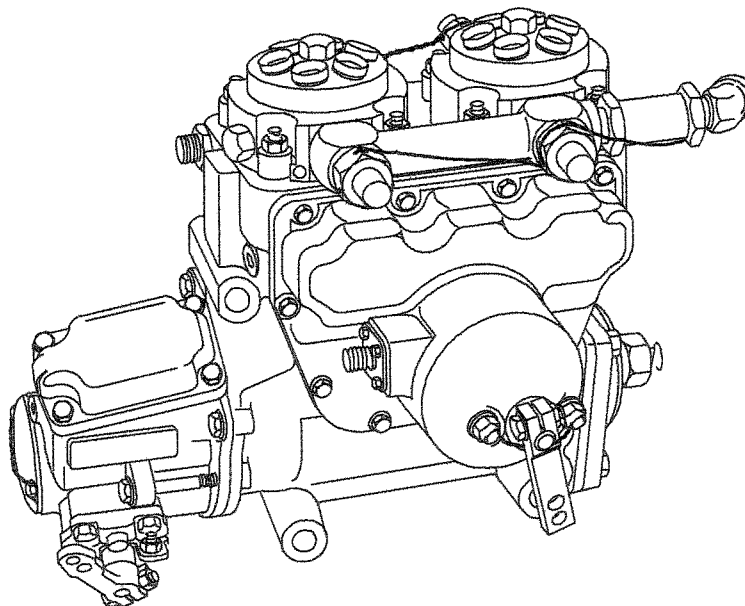
**M728 COMBAT ENGINEER VEHICLE**

**TECHNICAL MANUAL  
DIRECT SUPPORT AND GENERAL SUPPORT  
MAINTENANCE MANUAL**

(Including Direct Support, General Support,  
and Depot Maintenance  
Repair Parts and Special Tools List)

**PUMP,  
FUEL METERING AND DISTRIBUTING  
AMERICAN BOSCH MODEL PSB-12BT**

**NSN 2910-01-073-0124 (11684129-1, KT 8818)**



Supersedure Notice: This manual supersedes TM 9-2910-212-34&P, dated 27 June 1984, including all changes.  
Distribution Statement A: Approved for public release; distribution is unlimited.

---

**HEADQUARTERS, DEPARTMENT OF THE ARMY**

**DECEMBER 2005**

**EQUIPMENT DESCRIPTION AND DATA****0002 00****THIS WORK PACKAGE COVERS:**

Equipment Description and Data

**GENERAL DESCRIPTION**

The following terms will be used to identify pump areas and components (refer to Figure 1-1):

Governor end shall be called the front.

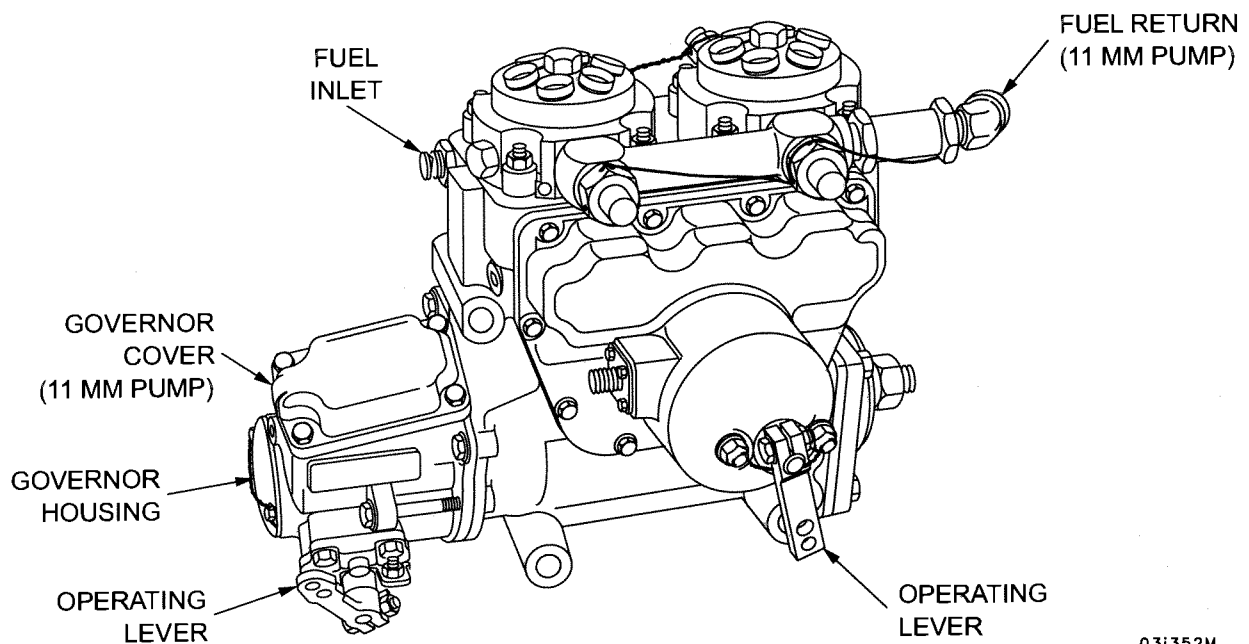
Drive end shall be called the rear.

Left and right sides of the pump will be determined when viewing the pump from the front.

Head assemblies are numbered 1 and 2 viewed from the rear.

**PURPOSE**

The pump is designed to deliver accurately metered quantities of high pressure fuel to the engine cylinders.



031352M

**Figure 1-1. PSB-12BT Fuel Injection Pump (11 mm) Right Front View.**



---

**EQUIPMENT DESCRIPTION AND DATA - CONTINUED**

---

**0002 00****MAJOR PUMP COMPONENTS**

For major pump components, refer to Figures 1-2 and 1-3.

**Pump housing:**

One-piece aluminum casting.

Has passages for lubricating oil flow (Figures 1-4 and 1-5).

Lubricating oil is supplied by the engine.

**Electrical/manual solenoid:**

Mounted in cover and solenoid.

Can be operated electrically or manually.

Shuts off fuel flow to engine.

**Fuel injection pump head assemblies include:**

Heads.

Fuel plungers.

Plunger sleeves.

Plunger drive spur gears.

Fuel delivery valves.

Plunger springs.

**Head assemblies have:**

Centrally ground and lapped bores with fitted plungers.

Counterbored and threaded upper ends for plunger bore screw.

Fuel discharge passages extending symmetrically from plunger bore.

Inclined passages from plunger bore to fuel delivery valves.

Inclined passages from fuel delivery valve to plunger annulus.

Tapped openings for inlet and outlet bleeder valve stems.

Drilled passages from inlet/outlet openings to fuel supply sump (Figure 1-4).

Supply sump located at center of plunger bore.

Sump accommodates plunger sleeve (Figure 1-4).

Additional passages for lubricating oil.

---

**EQUIPMENT DESCRIPTION AND DATA - CONTINUED**

---

**0002 00****MAJOR PUMP COMPONENTS - CONTINUED**

Fuel plunger, plunger sleeve and head assembly:

- Are matched components.
- Plunger is lapped to head and plunger sleeve.
- Plunger has parallel flats at lower end.
- Parallel flats lock plunger to spur gear through plunger guide.
- Guide will shear if plunger freezes preventing damage to other internal parts.
- Plunger spring and spring seats are held on plunger by plunger locks.

Fuel filter assembly:

- Contains a 10 micron filter element.
- Element is replaceable.
- Mounted to head assemblies by drilled bleeder valve stems and cap nuts.

Bleeder housing and valve assembly:

- Returns excess fuel to vehicle fuel tanks through hose and tube system.
- Bleeder valve is spring loaded.
- Maintains constant fuel pressure in head assemblies.
- Valve has 0.062 in. (1.57 mm) orifice allowing air to be bled off even if valve is closed.
- Mounted to head assemblies by drilled bleeder valve stems and cap nuts.

Camshaft has:

- Two three-lobed cams.
- Two spiral gears.
- Spiral gears are machined as part of camshaft.

Tappet assemblies:

- Consists of guide assembly, roller and roller pin.
- Cam lobe action is transmitted by tappet roller to guide assembly.
- Tappet assembly transmits cam lobe action to fuel plunger.

Gear shaft assemblies:

- Composed of quill shaft, bushing assembly, and camshaft driven helical gear.
- Transmit camshaft rotary motion to fuel plungers for fuel distribution.
- Plungers rotate at one half camshaft speed.

---

**EQUIPMENT DESCRIPTION AND DATA - CONTINUED**

---

**0002 00****MAJOR PUMP COMPONENTS - CONTINUED**

Governor housing components composed of:

- Weight and spider assembly.

- Sleeve assembly.

- Inner and outer governor springs.

- Fulcrum lever assembly.

- Operating linkages.

- Operating lever assembly.

Governor weight and spider assembly is an integral part of fuel injection pump assembly.

Weight and spider assembly:

- Pressed on camshaft extension.

- Has two moveable weight assemblies.

- Weights are pinned to opposite sides of friction drive spider.

- Weights swing freely on weight pins.

Sleeve assembly:

- Moves freely on camshaft extension.

- Governor weights act against thrust bearing on inner end of sleeve.

- Inner and outer springs act against outer end of sleeve.

- Slots on sides of sleeve receive the fulcrum lever pivot pins.

Fulcrum lever assembly:

- Has smoke limit cam and droop screw.

- Is controlled by the operating lever assembly and sleeve assembly.

- Fulcrum lever action is transmitted to smoke limit cam and droop screw.

- Control rod assembly transmits fulcrum lever action to fuel control lever assembly.

Fuel control lever assembly:

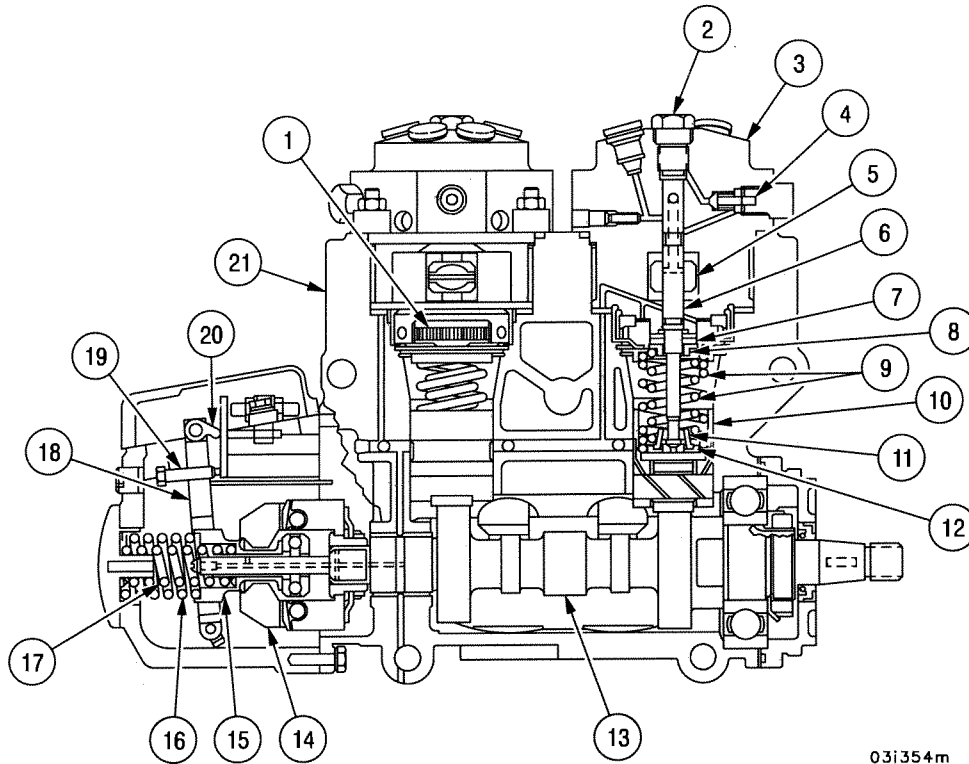
- Pivots on fuel control lever screw.

- Transmits control rod action to fuel control unit assemblies through yoke assembly.

Fuel control unit assemblies:

- Control position of fuel plunger sleeve in relation to plunger spill port.

- Spill port and sleeve relationship determine amount of fuel pumped each stroke.

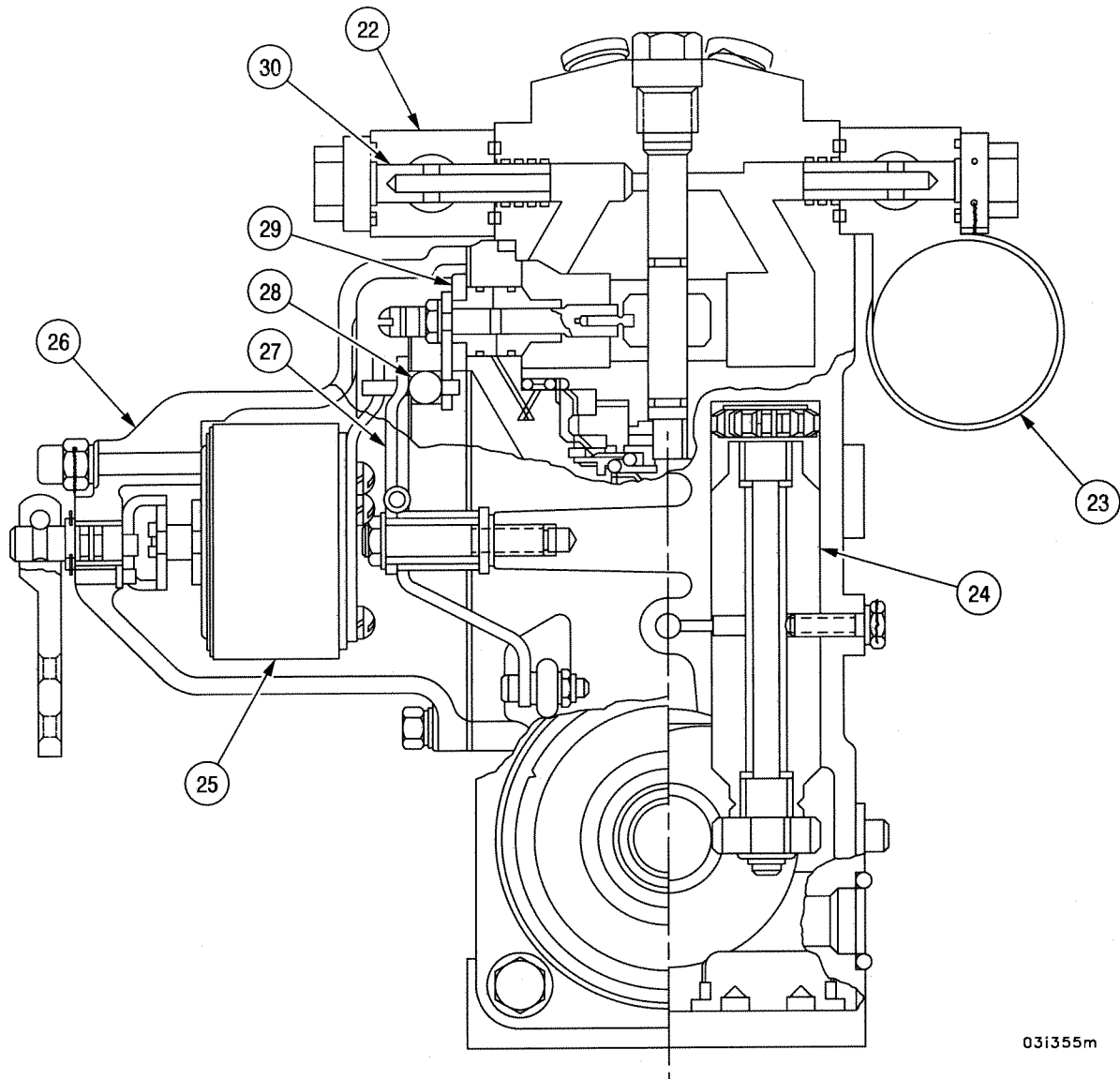


03i354m

- |                           |  |
|---------------------------|--|
| 1 Plunger drive spur gear | 12 Lower spring seat                   |
| 2 Plunger bore screw      | 13 Camshaft                            |
| 3 Head assembly           | 14 Governor weight and spider assembly |
| 4 Fuel delivery valve     | 15 Sleeve assembly                     |
| 5 Plunger sleeve          | 16 Governor outer spring               |
| 6 Fuel plunger            | 17 Governor inner spring               |
| 7 Plunger guide           | 18 Fulcrum lever assembly              |
| 8 Upper spring seat       | 19 Droop screw                         |
| 9 Plunger springs         | 20 Smoke limit cam                     |
| 10 Tappet assembly        | 21 Pump housing                        |
| 11 Plunger lock           |  |

Figure 1-2. Major Pump Components (Sheet 1 of 2).

(Cutaway through Governor Housing, Camshaft, and Head Assembly)



03i355m

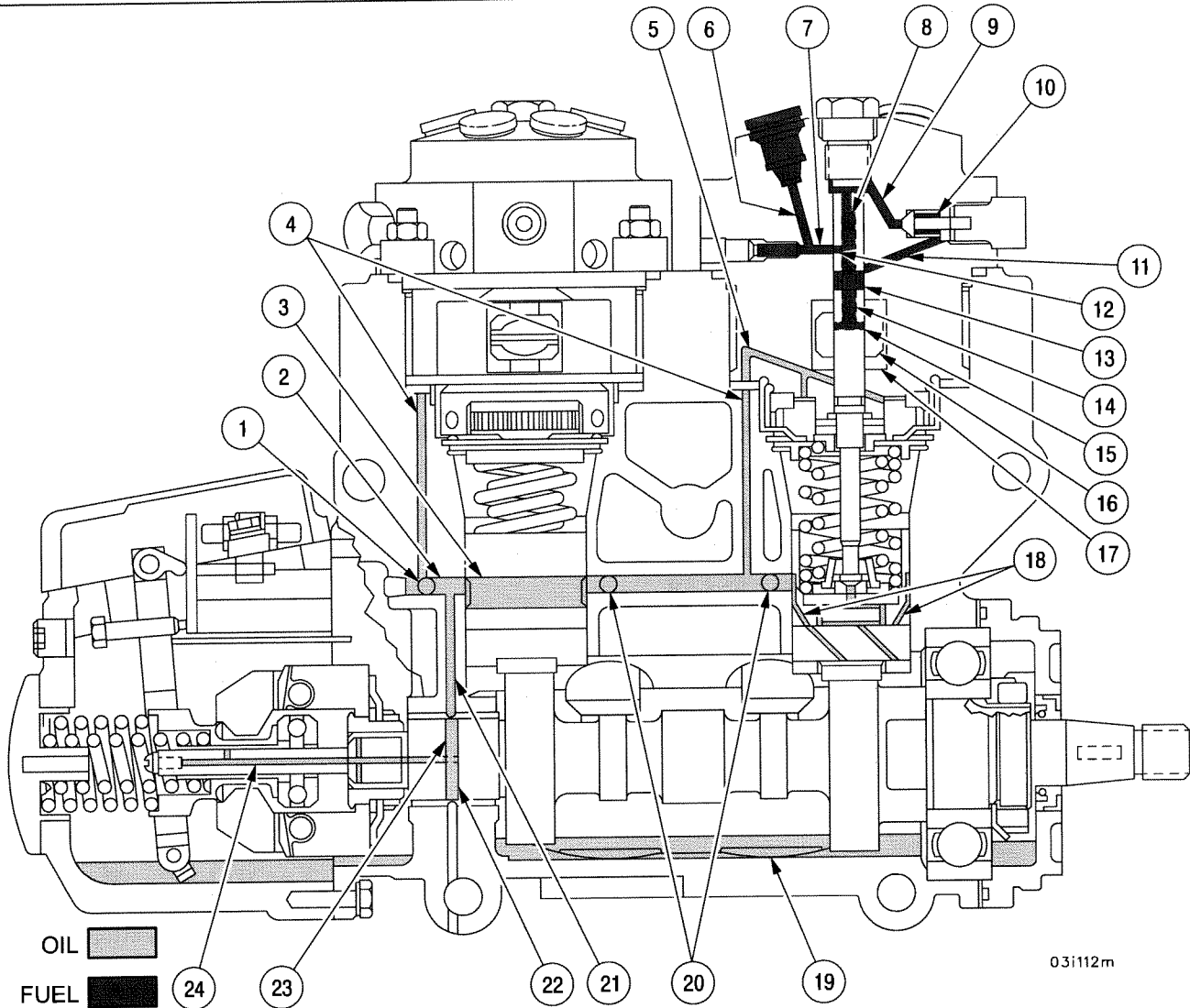
- 22 Bleeder housing and valve assembly
- 23 Fuel filter assembly
- 24 Gear shaft assembly
- 25 Electrical solenoid
- 26 Cover and solenoid
- 27 Fuel control lever
- 28 Fuel control yoke assembly
- 29 Fuel control unit assembly
- 30 Bleeder valve stem

Figure 1-3. Major Pump Components (Sheet 2 of 2).

(Cutaway through Cover and Solenoid, Head Assembly, and Gear Shaft Assembly)

## EQUIPMENT DESCRIPTION AND DATA - CONTINUED

0002 00



- 1 Horizontal oil passage
- 2 Main horizontal oil passage
- 3 Tappet assembly annulus
- 4 Upper vertical oil passage
- 5 Hydraulic head oil passage
- 6 Vertical outlet fuel passage
- 7 Horizontal outlet fuel passage
- 8 Fuel port
- 9 Delivery valve upper fuel passage
- 10 Fuel delivery valve
- 11 Delivery valve lower fuel passage
- 12 Plunger distributing slot

- 13 Plunger annulus
- 14 Plunger vertical fuel passage
- 15 Plunger horizontal fuel passage
- 16 Plunger sleeve
- 17 Fuel supply sump
- 18 Tappet assembly oil passage
- 19 Oil sump
- 20 Gear shaft oil passage
- 21 Lower vertical oil passage
- 22 Camshaft journal oil passage
- 23 Camshaft bushing annulus
- 24 Camshaft oil passage

Figure 1-4. Fuel and Oil Flow Diagram (Sheet 1 of 2).

(Cutaway through Governor Housing, Camshaft, and Head Assembly)

---

**EQUIPMENT DESCRIPTION AND DATA - CONTINUED**

---

**0002 00****MAJOR PUMP COMPONENTS - CONTINUED**

## Lubrication System (Figures 1-4 and 1-5):

Pressurized engine oil is delivered to the fuel injection pump through an external hose.

Pump housing has one main horizontal oil passage to lubricate tappet assemblies and gear shaft assemblies.

One vertical passage provides lubrication for head assembly components.

Another vertical passage provides lubrication for camshaft journal and governor weight and spider assembly components.

Camshaft lobes, ball bearing and gear shaft drive gear are splash lubricated.

Overflow oil drains from oil outlet on left side of pump.

## Fuel System (Figures 1-4 and 1-5):

## Fuel flow:

Continuous flow of filtered fuel enters pump through filter assembly.

Inlet flow branches in two directions.

One branch flows through sump, fuel outlet housing, and bleeder valve assembly.

One branch flows through plunger fuel ports to pressure chamber when plunger is at bottom of stroke.

Constant flow of fuel also acts as coolant for pump heads.

## Fuel pumping and distribution:

Provided by camshaft.

Camshaft rotates at engine speed.

Camshaft action lifts and rotates plungers.

During two revolutions of camshaft each plunger completes six strokes and one revolution.

During lower portion of stroke, plunger pressure chamber is filled through fuel port.

During upper portion of stroke fuel port is closed off and fuel is compressed.

Compressed fuel opens fuel delivery valve and fuel flows to plunger annulus and distributing slot.

Distributing slot aligns with outlet port and fuel is delivered to engine cylinder.

Continued upward movement of plunger uncovers fuel spill port.

Fuel flows from pressure chamber to fuel sump relieving pressure.

Delivery valve closes and pumping cycle is completed.

## Fuel metering control:

Position of plunger sleeve determines quantity of fuel delivered for each stroke.

With plunger sleeve raised effective stroke of plunger is longer and more fuel is delivered.

Lowering plunger sleeve reduces effective stroke and less fuel is delivered.

Lowering sleeve to extreme position uncovers both the fill port and spill port and no fuel can be delivered.

Position of plunger sleeve is controlled by the governor weight and spider assembly.

Increase in camshaft speed causes governor weight assemblies to move outward.

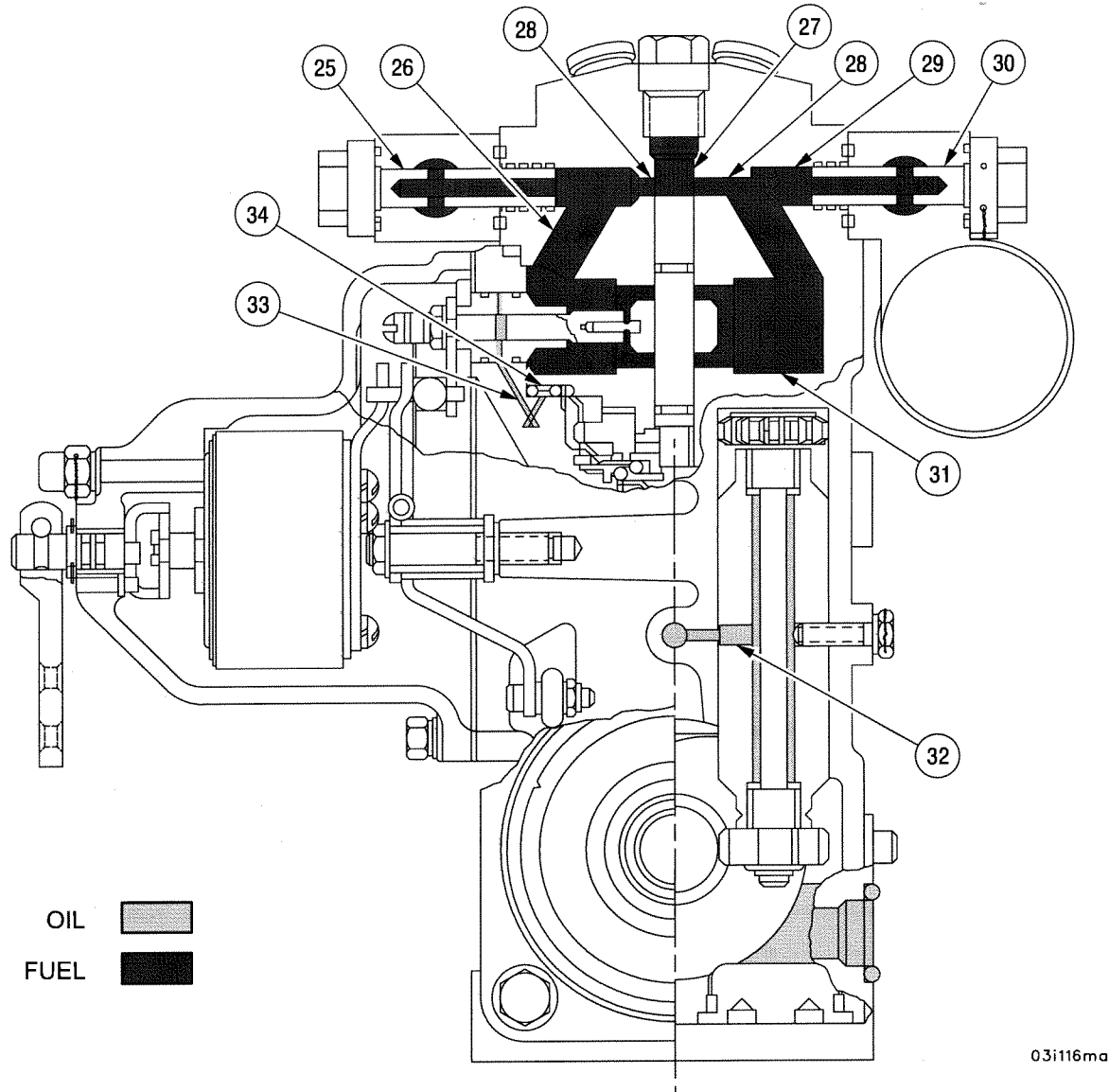
Outward weight movement forces governor sleeve against governor springs.

Spring tension balances governor weight action at any given speed after sleeve assembly has shifted.

Governor sleeve assembly is connected to plunger sleeve through fulcrum lever and linkage.

For any given engine speed there is a corresponding governor sleeve assembly and plunger sleeve position.

Adjustable smoke limit cam in linkage path between governor and plunger sleeve limits maximum fuel delivery to specified limits to prevent overfueling.



- 25 Bleeder valve stem
- 26 Fuel outlet passage
- 27 Plunger bore pressure chamber
- 28 Fuel port
- 29 Fuel inlet passage
- 30 Bleeder valve stem
- 31 Hydraulic head spill port
- 32 Gear shaft oil passage
- 33 Pump housing oil passage
- 34 Spacer

Figure 1-5. Fuel and Oil Flow Diagram (Sheet 2 of 2).

(Cutaway through Cover and Solenoid, Head Assembly, and Gear Shaft Assembly)



---

**EQUIPMENT DESCRIPTION AND DATA - CONTINUED**

---

**0002 00****DIFFERENCES BETWEEN MODELS**

Early and late model pumps are similar in design. Early model 11 mm pumps have dust shields, late model 11 mm pumps do not. Late model 11 mm pumps incorporate cold weather start components to permit easier engine starts in cold weather. Early model pumps, not so equipped, will be modified at time of overhaul by requisitioning Injection Pump Cold Weather Start Modification Kit, Part No. 12275776.

Cold Start Components were incorporated to provide more fuel when starting the engine in cold temperatures. Silicone lubricant was also added to provide smoother operation of the fuel control units and the electrical solenoid internal lever. New cold start components are:

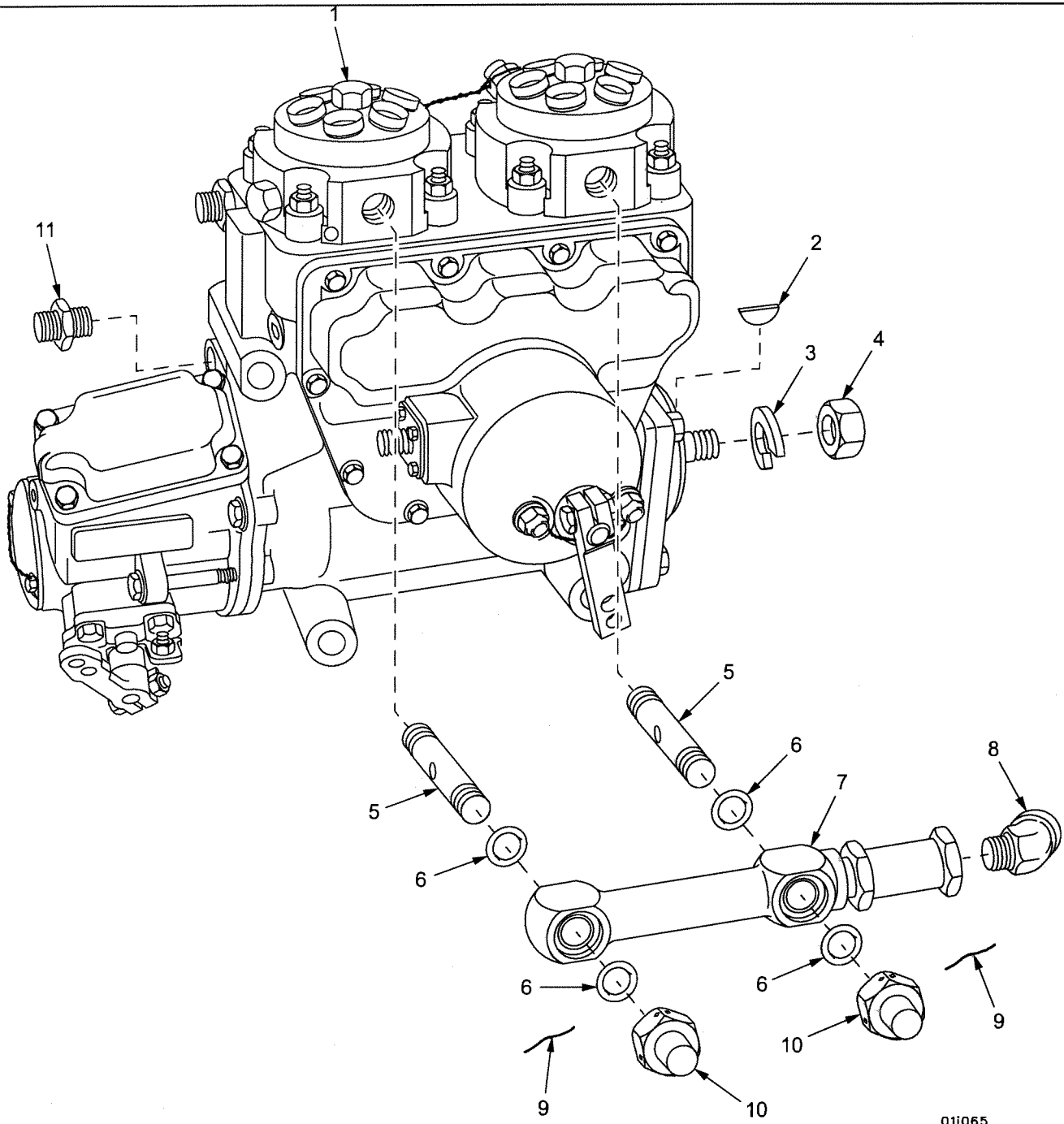
- Fulcrum lever with droop screw.

- Operating lever assembly spring plate.

- Fuel control levers.

- Fuel control unit spacers.

Manual Coverage. This manual covers pumps that have cold start components.



01i065

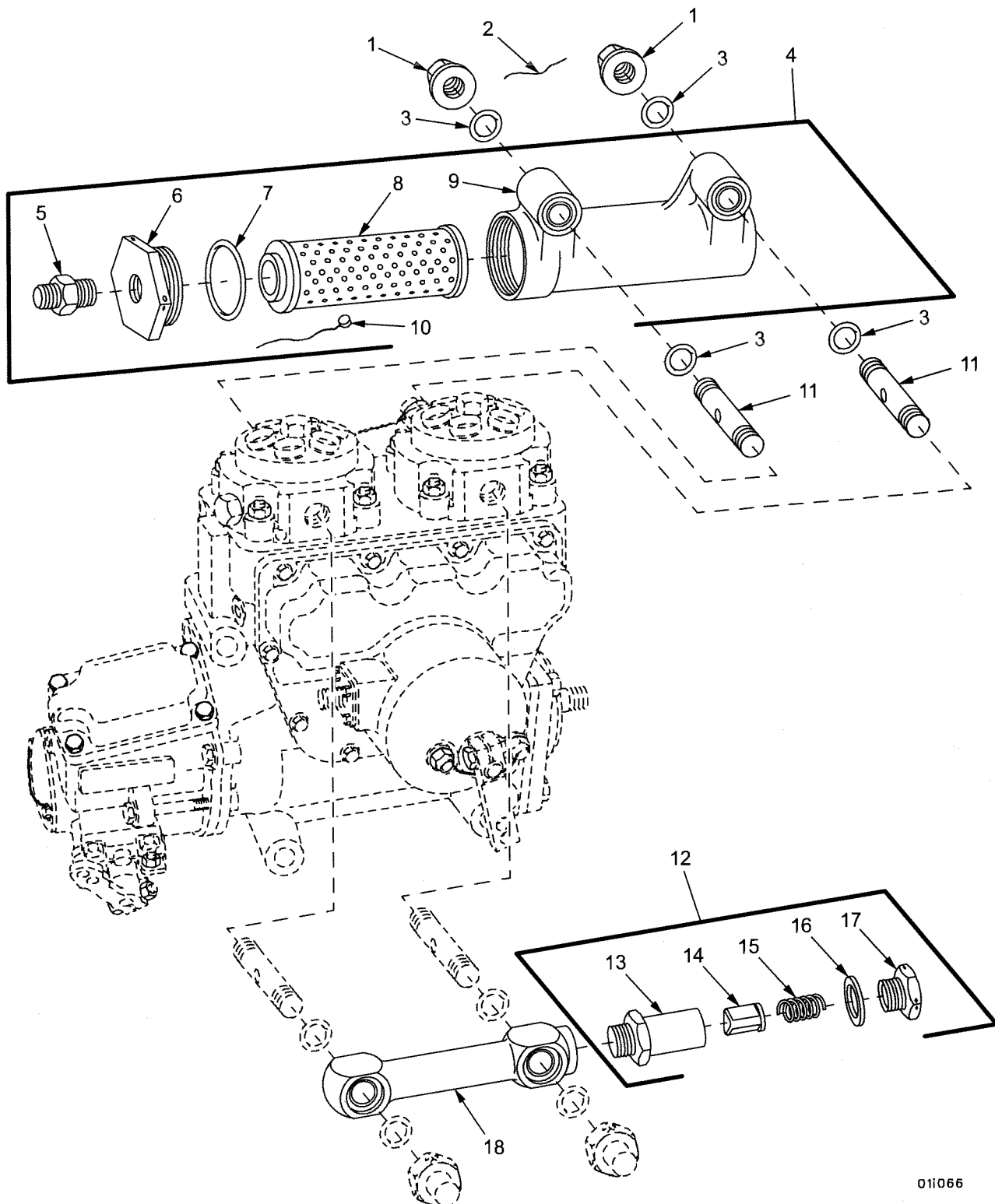
Figure 1. Bleeder Housing, Valve Assembly and Associated Parts.

## RPSTL WORK PACKAGE - CONTINUED

0040 00

(1) ITEM NO	(2) SMR	(3) NSN	(4) CAGE	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODE (UOC)	(7) QTY
					GROUP 03 FUEL PUMP GROUP 0302 FUEL PUMP FIGURE 1 BLEEDER HOUSING, VALVE ASSEMBLY AND ASSOCIATED PARTS	
1	XAFHD			19207 11668626-1	PUMP, FUEL, METERING 11MM.....	1
2	PAFZZ	5315-00-282-0341		19207 8761412	KEY, WOODRUFF PUMP DRIVE COUPLING TO PUMP DRIVE SHAFT.....	1
3	PAFZZ	5310-00-584-7888		96906 MS35338-51	WASHER, LOCK PUMP DRIVE SHAFT.....	1
4	PAFZZ	5310-00-655-9590		19207 7340058	NUT, PLAIN, HEXAGON PUMP DRIVE SHAFT.	1
5	PAFZZ	4820-00-678-4724		19207 7320493	STEM, FLUID VALVE PUMP HEAD TO BLEEDER VALVE HOUSING.....	2
6	PAFZZ	5330-00-579-3156		96906 MS28775-116	PACKING, PREFORMED FUEL RETURN HOUSING TO STEMS(2), CAP NUTS(2) PART OF KIT P/N 5702632.....	4
7	PFFFF	2910-00-475-3463		19207 11684115	HOUSING AND VALVE FUEL RETURN AND BLEEDER SEE FIGURE 2 FOR PARTS BREAKOUT.....	1
8	PAFZZ	4730-00-595-1868		81336 454098	ELBOW, PIPE FUEL RETURN.....	1
8	PAFZZ	4730-00-555-1764		96906 MS51504A8	UOC:A, ELBOW, PIPE TO TUBE.....	1
9	MFFZZ			96906 MS20995NC40-12	UOC:B, WIRE, NONELECTRICAL BLEEDER VALVE TO CAP NUT TO CAP NUT FABRICATE FROM WIRE, NONELECTRICAL 9525-00-990-7799 2 PCS. 12 IN. LG. REQUIRED.....	2
10	PAFZZ	5310-00-655-9593		19207 7340055	NUT, PLAIN, CAP FUEL RETURN TO STEM..	2
11	PAFZZ	4730-00-800-2830		19207 10865239	ADAPTER, STRAIGHT, PI OIL INLET HOSE. UOC:A,	1
11	PAFZZ	4730-01-434-5207		01843 AD882	ADAPTER, STRAIGHT, PI OIL INLET HOSE. UOC:B,	1

END OF FIGURE



011066

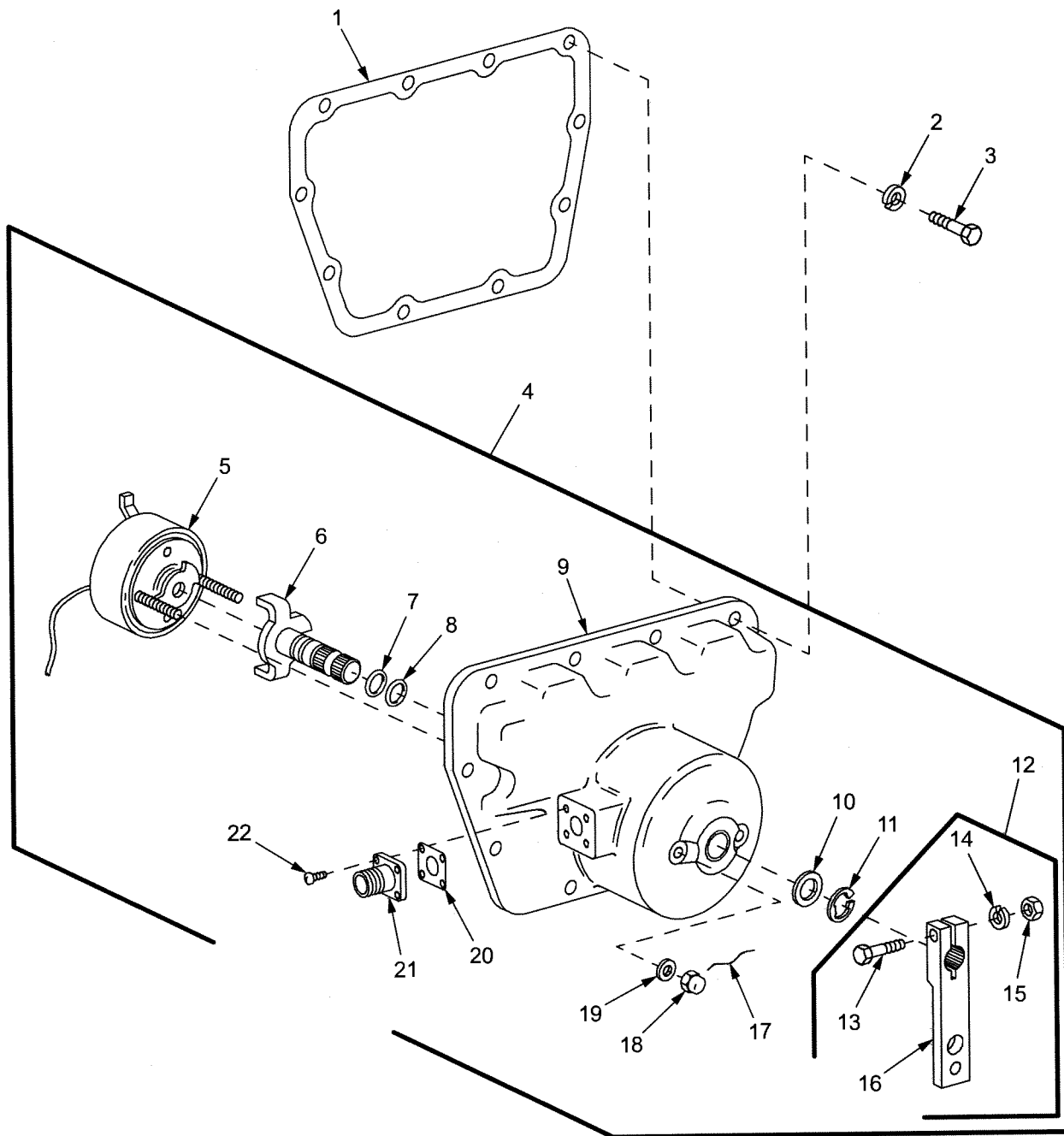
Figure 2. Filter Assembly, Bleeder Valve Assembly and Associated Parts.

## RPSTL WORK PACKAGE - CONTINUED

0040 00

(1) ITEM NO	(2) SMR	(3) NSN	(4) CAGE	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODE (UOC)	(7) QTY
					GROUP 0302 FUEL PUMP FIGURE 2 FILTER ASSEMBLY, BLEEDER VALVE ASSEMBLY AND ASSOCIATED PARTS	
1	KFHZZ		01843	NT888	NUT, CAP FILTER ASSEMBLY TO STEMS..	2
2	MHHZZ		96906	MS20995NC40-12	PART OF KIT P/N 5704356..... WIRE, NONELECTRICAL CAP NUT TO CAP..	1
3	PAFZZ	5330-00-579-3156	96906	MS28775-116	NUT FABRICATE FROM WIRE, NONELECTRICAL 9525-00-990-7799, 1 PC. 12 IN. LG. REQUIRED.....	4
4	KFFFF		01843	FE882A	PACKING, PREFORMED FILTER ASSEMBLY TO STEMS (2), CAP NUTS (2) PART OF KIT P/N 5704356, 5702632.....	1
5	PAFZZ	4730-00-402-5143	02978	10951334	FILTER ASSEMBLY FUEL INLET PART OF KIT P/N 5704356.....	1
6	XAFZZ		01843	CP883	ADAPTER, STRAIGHT, PI FUEL FILTER INLET.....	1
7	PAFZZ	5330-00-819-5111	96906	MS28778-24	CAP FILTER INLET HOUSING.....	1
8	KFFZZ		19207	10951481	PACKING, PREFORMED FUEL INLET HOUSING CAP PART OF KIT P/N 5702739	1
9	XAFZZ		01843	HG8817	FILTER ELEMENT PART OF KIT P/N 5702739.....	1
10	PAFZZ	5340-00-902-0426	96906	MS51938-6	HOUSING, MANIFOLD FUEL INLET.....	1
11	PAFZZ	4820-00-678-4724	19207	7320493	SEAL, ANTIPIRFERAGE FILTER INLET HOUSING CAP PART OF KIT P/N 5705050	2
12	PFFFF	4820-00-613-6297	19207	11684114	STEM, FLUID VALVE PUMP HEAD TO FILTER ASSEMBLY.....	1
13	XAFZZ	4820-01-296-9362	19207	10951144	VALVE, SAFETY RELIEF BLEEDER.....	1
14	XAFZZ		19207	10951143	HOUSING, BLEEDER VALVE.....	1
15	PADZZ	5340-00-510-4117	19207	11684113	VALVE, BLEEDER.....	1
16	PAFZZ	5365-00-655-9589	19207	7340054	SPRING, HELICAL, COMP BLEEDER VALVE.	1
17	PAFZZ	5340-00-678-4727	19207	8682456	SPACER, RING RETAINER.....	1
18	PBFZZ	2910-01-298-5376	19207	10935512	RETAINER, HELICAL, CO.....	1
					HOLDER, FUEL INJECTO.....	1

END OF FIGURE



01i054

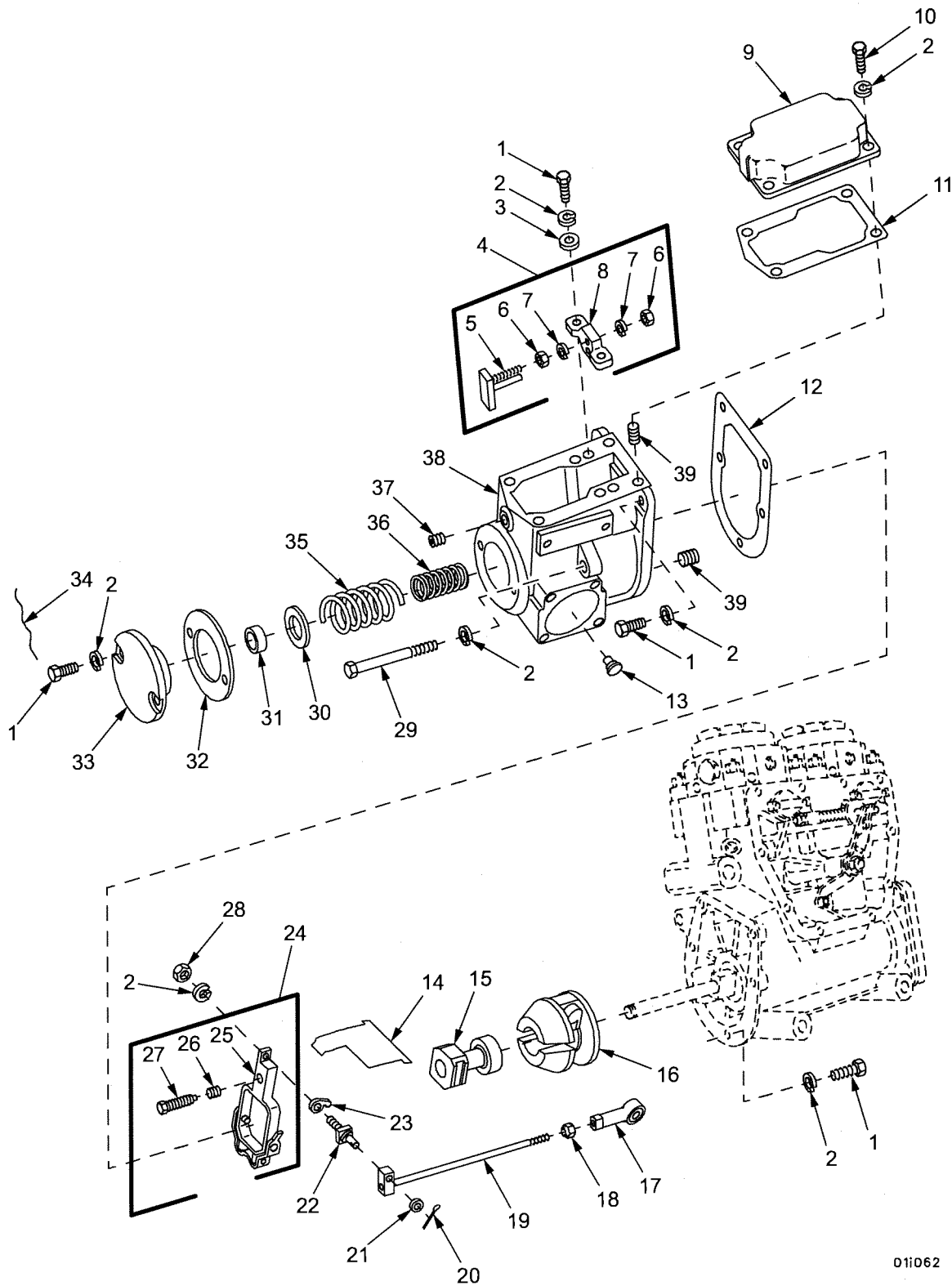
Figure 3. Cover and Solenoid Assembly.

## RPSTL WORK PACKAGE - CONTINUED

0040 00

(1) ITEM NO	(2) SMR	(3) NSN	(4) CAGE	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODE (UOC)	(7) QTY
					GROUP 0302 FUEL PUMP FIGURE 3 COVER AND SOLENOID ASSEMBLY	
1	PAHZZ	5330-00-786-0190	01843	GA8814	GASKET SOLENOID COVER ASSEMBLY	1
2	PAHZZ	5310-00-582-5965	80205	MS35338-44	PART OF KIT P/N 5702632..... WASHER, LOCK PART OF KIT P/N 5705050. .5705051.....	10
3	PAHZZ	5306-00-816-5803	01843	SC1110	BOLT, MACHINE.....	10
4	PFHHH	2910-00-466-7473	01843	CV8816A	COVER AND SOLENOID MANUAL SHUT-OFF.	1
5	PFHZZ	2920-00-449-0107	01843	S0882A	.SOLENOID, ELECTRICAL.....	1
6	PAHZZ	2910-00-467-2582	02978	679672	.LEVER ASSEMBLY, SHUT.....	1
7	PAHZZ	5330-00-310-6559	01843	GA401346	.GASKET PART OF KIT P/N 5705050, 5702632.....	1
8	PAHZZ	5330-00-583-3473	01843	GA1144	.PACKING, PREFORMED PART OF KIT P/N 5705050, 5702632.....	1
9	XAHZZ		01843	CV8817A	.COVER.....	1
10	PAHZZ	5310-00-166-1412	0AHP5	27D123	.WASHER, FLAT.....	1
11	PAHZZ	5365-01-012-7353	02978	RG886	.RING, RETAINING.....	1
12	PBHHH	3040-00-466-7469	02978	679671	.LEVER, REMOTE CONTRO.....	1
13	PAHZZ	5306-00-366-8857	01843	SC7961	.BOLT, MACHINE.....	1
14	PAHZZ	5310-00-582-5965	80205	MS35338-44	.WASHER, LOCK PART OF KIT P/N 5705050.....	1
15	PAHZZ	5310-01-493-5390	96906	MS35691-5	.NUT, PLAIN, HEXAGON.....	1
16	XAHZZ		01843	LE8839	.LEVER.....	1
17	PAHZZ	2990-00-977-2591	6N299	4506994-5	.WIRE BEARING PLATE.....	1
18	PAHZZ	5310-01-112-7922	01843	NT886	.NUT, PLAIN, CAP.....	1
19	PFHZZ	5310-00-253-8721	82254	CFN70306	.WASHER, FLAT SOLENOID CAP NUT.....	2
20	PAHZZ	5330-00-827-5635	19207	7383426	.GASKET CONNECTOR RECEPTACLE PART OF KIT 5702632.....	1
21	PAHZZ	5935-00-810-8094	96906	MS3102R8S1P	.CONNECTOR, RECEPTACL.....	1
22	PAHZZ	5305-00-810-8093	21450	420429	.SCREW, ASSEMBLED WAS CONNECTOR RECEPTACLE.....	4

END OF FIGURE



011062

Figure 4. Governor Housing, Fulcrum Lever, Sleeve Assembly, Weight and Spider Assembly and Associated Parts.



## RPSTL WORK PACKAGE - CONTINUED

0040 00

(1) ITEM NO	(2) SMR	(3) NSN	(4) CAGE	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODE (UOC)	(7) QTY
					GROUP 0302 FUEL PUMP FIGURE 4 GOVERNOR HOUSING, FULCRUM LEVER, SLEEVE ASSEMBLY, WEIGHT AND SPIDER ASSEMBLY AND ASSOCIATED PARTS	
1	XAHZZ		21450	454724	SCREW, CAP, HEXAGON H. ....	7
2	PAHZZ	5310-00-582-5965	80205	MS35338-44	WASHER, LOCK PART OF KIT P/N 5705050, 5705051. ....	14
3	PAHZZ	5310-00-515-3030	19204	5153030	WASHER, FLAT STOP PLATE BRIDGE TO GOVERNOR HOUSING. ....	2
4	PAHZZ	2910-00-064-6267	19207	10885779	BRIDGE, STOP PLATE. ....	1
5	XAHZZ		01843	PL79123A	PLATE ASSEMBLY, STOP. ....	1
6	PAHZZ	5310-01-493-5390	96906	MS35691-5	NUT, PLAIN, HEXAGON STOP PLATE. ....	2
7	PAHZZ	5310-00-582-5965	80205	MS35338-44	WASHER, LOCK STOP PLATE. ....	2
8	XAHZZ		01843	BK7938C	BRIDGE STOP, PLATE. ....	1
9	XAHZZ		01843	CV9032C	COVER, GOVERNOR. ....	1
10	XDHZZ	5306-00-816-5803	01843	SC1110	BOLT, MACHINE GOVERNOR COVER TO HOUSING. ....	4
11	PAHZZ	5330-00-310-6556	01843	GA908	GASKET GOVERNOR COVER, PART OF KIT P/N 5705050, 5705051. ....	1
12	KFHZZ		01843	GA8813	GASKET GOVERNOR HOUSING, PART OF KIT P/N 5702632. ....	1
13	KFHZZ		01843	PN901A	PIN, PIVOT FULCRUM LEVER BRACKET, PART OF KIT P/N 5705051. ....	1
14	XAHZZ		01843	8A881	BAFFLE, OIL GOVERNOR HOUSING. ....	1
15	KFHZZ		19207	7748546	SLEEVE ASSEMBLY GOVERNOR, PART OF KIT P/N 8705051. ....	1
16	PAHHZ	2990-00-562-1146	01843	WT9025A	WEIGHT AND SPIDER A SEE FIGURE 5 FOR PARTS BREAKOUT	1
17	PAHZZ	3120-00-845-5726	19207	7748622	BEARING, PLAIN, ROD E GOVERNOR CONTROL ROD. ....	1
18	PAHZZ	5310-00-902-6676	96906	MS21083N3	NUT, SELF-LOCKING, HE GOVERNOR CONTROL END. ....	1
19	KFHZZ		19207	10951322	ROD CONTROL ASSEMBL PART OF KIT P/N 5705051. ....	1
20	KFHZZ		21450	137128	PIN, COTTER CONTROL ROD TO FULCRUM LEVER, PART OF KIT P/N 5705051. ....	1
21	KFHZZ		19207	7748547	WASHER CONTROL ROD TO FULCRUM LEVER PART OF KIT P/N 5705051. ....	1
22	XAHZZ	5305-01-504-7169	01843	SC8814	SCREW SMOKE LIMIT CAM. ....	1
23	KFHZZ	3040-00-362-7035	01843	CA401255	CAM, SMOKE LIMIT PART OF KIT P/N 5705051	1
24	KFHZZ	2390-01-491-4821	01843	LE8856A	FULCRUM LEVER ASSEM GOVERNOR, PART OF KIT, P/N 5705051. ....	1
25	XAHZZ		01843	LE8855A	FULCRUM LEVER. ....	1
26	PAHZZ	5325-01-214-7758	01843	IT1011	INSERT, SCREW THREAD HELICAL COIL...	1
27	PAHZZ	5305-01-170-8472	01843	SC8830	DROOP SCREW. ....	1
28	PAHZZ	5310-01-493-5390	96906	MS35691-5	NUT, PLAIN, HEXAGON SMOKE LIMIT CAM, PART OF KIT P/N 5705051. ....	1
29	XAHZZ		01843	SC1877	SCREW GOVERNOR HOUSING TO INJECTION PUMP HOUSING. ....	2

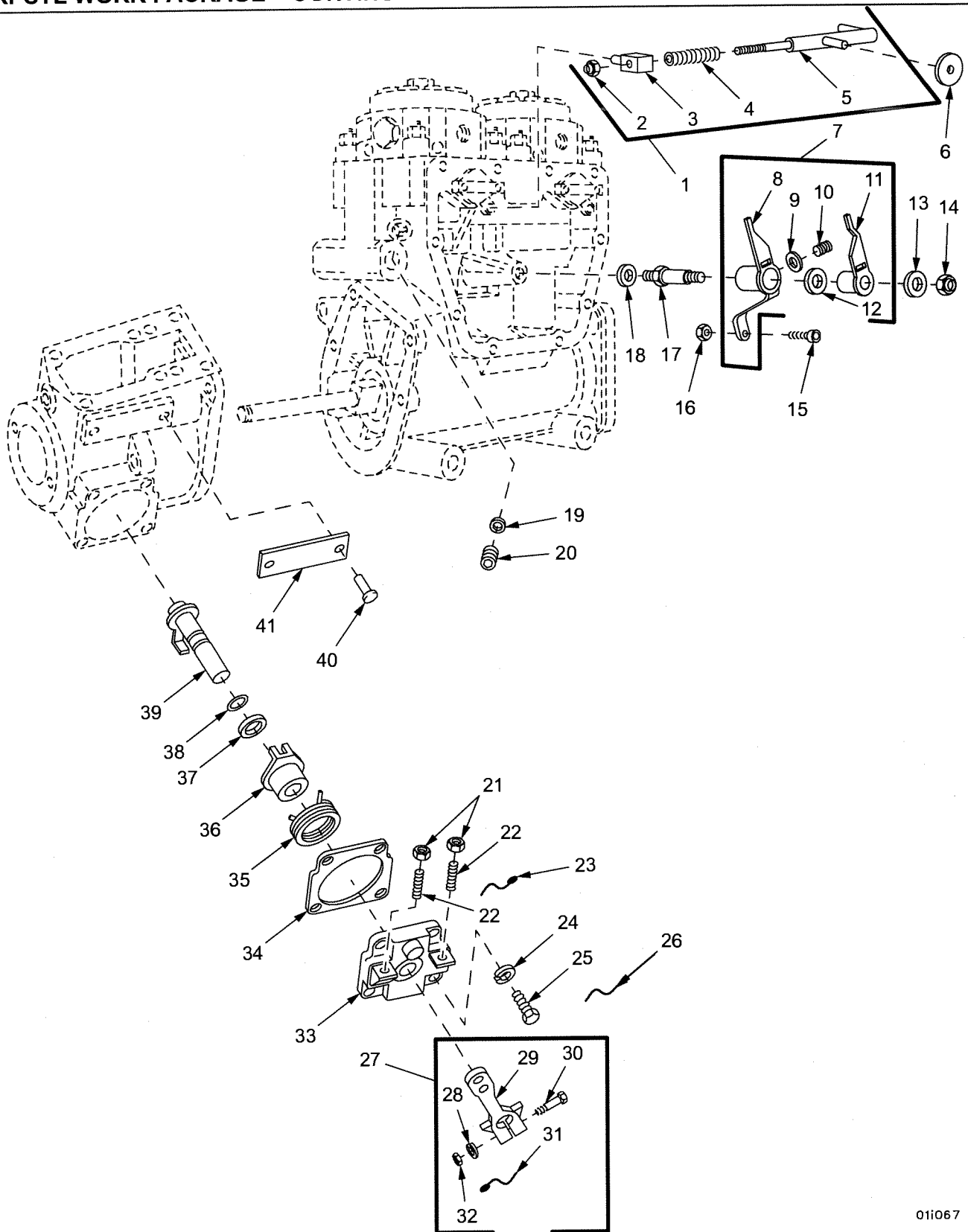
## RPSTL WORK PACKAGE - CONTINUED

0040 00

(1) ITEM NO	(2) SMR	(3) NSN	(4) CAGE	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODE (UOC)	(7) QTY
30	PAHZZ	5310-00-595-5313	01843	SR400440	WASHER,FLAT 0.042 IN THK,GOVERNOR OUTER SPRING,PART OF KIT P/N 5702638	1
30	PAHZZ	5310-00-595-6391	01843	SR400441	WASHER,FLAT 0.058 IN THK,GOVERNOR OUTER SPRING,PART OF KIT P/N 5702638	1
30	PAHZZ	5310-00-262-5646	01843	SR400442	WASHER,FLAT 0.083 IN THK,GOVERNOR OUTER SPRING,PART OF KIT P/N 5702638	1
30	PAHZZ	5310-00-362-7092	01843	SR7914-1	WASHER,FLAT 0.020 IN THK,GOVERNOR OUTER SPRING,PART OF KIT P/N 5702638	1
30	KFHZZ		01843	SR7914-5	SPACER,ADJUSTING 0156 IN THK, GOVERNOR OUTER SPRING,PART OF KIT P/N 5702638.....	1
30	KFHZZ		01843	SR7914-6	SPACER,ADJUSTING 0.030 IN THK, GOVERNOR OUTER SPRING,PART OF KIT P/N 5702638.....	1
31	PAHZZ	5365-00-362-7089	01843	SR400410	SPACER,GOVERNOR FUE 0.042 IN THK, GOVERNOR INNER SPRING,PART OF KIT P/N 5702638.....	1
31	PAHZZ	5310-00-167-0823	81343	AN960-816	WASHER,FLAT 0.058 IN THK,GOVERNOR INNER SPRING,PART OF KIT P/N 5702638	1
31	PAHZZ	5310-00-595-5315	01843	SR400412	WASHER,FLAT 0.083 IN THK,GOVERNOR INNER SPRING,PART OF KIT P/N 5702638	1
31	KFHZZ		01843	SR799-5	SPACER,ADJUSTING 0.177 IN THK, GOVERNOR INNER SPRING,PART OF KIT P/N 5702638.....	1
31	KFHZZ		01843	SR799-6	SPACER,ADJUSTING 0.276 IN THK, GOVERNOR INNER SPRING,PART OF KIT P/N 5702638.....	1
31	PAHZZ	5310-00-362-7088	99066	SR799-1	WASHER,FLAT 0.020 IN THK,GOVERNOR INNER SPRING,PART OF KIT P/N 5702638	1
32	PAHZZ	5330-00-640-9587	01843	GA902	GASKET PART OF KIT P/N 5705051, 5702632.....	1
33	PAHZZ	3040-01-378-6184	01843	CP901	CAP,LINEAR ACTUATIN.....	1
34	PAHZZ	2990-00-977-2591	6N299	4506994-5	WIRE BEARING PLATE GOVERNOR CAP....	1
35	PAHZZ	5340-00-830-3882	01843	SP7951-13	SPRING,HELICAL,COMP GOVERNOR CAP...	1
36	PAHZZ	5360-00-785-6358	01843	SP7950/3	SPRING,HELICAL,COMP INNER,GOVERNOR.	1
37	PAHZZ	4730-00-954-1281	81348	WW-P-471ACABCB	PLUG,PIPE GOVERNOR HOUSING ACCESS..	1
38	XAHZZ		01843	HG8822A	HOUSING,GOVERNOR.....	1
39					HELICOIL,2.50-20 UNC S/N S 8F7790..	5

END OF FIGURE





01i067

Figure 5. Yoke Assembly, Lever Assembly, Operating Lever Assembly and Associated Parts.

## RPSTL WORK PACKAGE - CONTINUED

0040 00

(1) ITEM NO	(2) SMR	(3) NSN	(4) CAGE	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODE (UOC)	(7) QTY
					GROUP 0302 FUEL PUMP FIGURE 5 YOKE ASSEMBLY, LEVER ASSEMBLY, OPERATING LEVER ASSEMBLY AND ASSOCIATED PARTS	
1	KFH HH		01843	Y0881A	YOKE ASSEMBLY PART OF KIT P/N 5705051.....	1
2	XAHZZ		01843	NT1218	.NUT.....	1
3	XAHZZ		01843	PN8821	.PIN, YOKE.....	1
4	PAHZZ	5340-00-529-6945	01843	SP9014	.SPRING, HELICAL, COMP.....	1
5	XAHZZ		01843	RD883A	.ROD, YOKE.....	1
6	KFHZZ		01843	SR8811-1	SPACER PART OF KIT P/N 5705051.....	1
6	KFHZZ		01843	SR8811-2	SPACER PART OF KIT P/N 5705051.....	1
7	KFH HH		01883	LE409004	LEVER ASSEMBLY, FUEL PART OF KIT P/N 5702765.....	1
8	XAHZZ		01843	LE409078	.LEVER, FUEL CONTROL.....	1
9	PAHZZ	5340-01-449-1424	01843	GU408541	.SEAT.....	1
10	PAHZZ	5360-01-433-8974	01843	SP408500	.SPRING, HELICAL, COMP.....	1
11	XAHZZ		01843	LE409077	.LEVER, FUEL CONTROL.....	1
12	PAHZZ	5365-01-450-0691	01843	SR8812	.SPACER.....	1
13	KFHZZ		01843	WA1806	WASHER PART OF KIT P/N 5702765.....	1
14	PAHZZ	5310-00-176-6677	01843	NT1161	NUT, PLAIN, SINGLE BA PART OF KIT P/N 5702765.....	1
15	PAHZZ	5305-00-983-6652	96906	MS16998-29	SCREW, CAP, SOCKET HE GOVERNOR.....	1
16	PAHZZ	5310-00-902-6676	96906	MS21083N3	CONTROL ROD TO LEVER.....	1
17	KFHZZ		21843	SC8825	NUT, SELF-LOCKING, HE GOVERNOR.....	1
18	XAHZZ		01843	WA22-108L	CONTROL ROD TO LEVER.....	1
19	PAHZZ	5365-00-245-5420	01843	GA7965	SCREW PART OF KIT P/N 5702675.....	1
20	PAHZZ	5365-01-172-1823	01843	PG886	WASHER FUEL CONTROL LEVER SCREW....	1
21	PAHZZ	5310-00-768-0319	96906	MS51968-2	SPACER, RING PART OF KIT P/N 5702632.....	1
22	PAHZZ	5305-01-227-8675	19207	11621586	PLUG, MACHINE THREAD.....	1
23	PAHZZ	5340-00-902-0426	96906	MS51938-6	NUT, PLAIN, HEXAGON IDLE AND FULL SPEED, PART OF KIT P/N 5705050.....	1
24	PAHZZ	5310-00-582-5965	80205	MS35338-44	SETScrew IDLE AND FULL SPEED ADJUSTING SCREW, PART OF KIT P/N 5705050.....	2
25	KFHZZ		19207	11621881	SEAL, ANTIPILFERAGE IDLE AND FULL SPEED ADJUSTING SCREW NUT, PART OF KIT P/N 5705050.....	1
					WASHER, LOCK BEARING PLATE TO GOVERNOR HOUSING, PART OF KIT P/N 5705050.....	1
					SCREW, CAP, HEXAGON H BEARING PLATE TO GOVERNOR HOUSING, PART OF KIT P/N 5705050.....	4

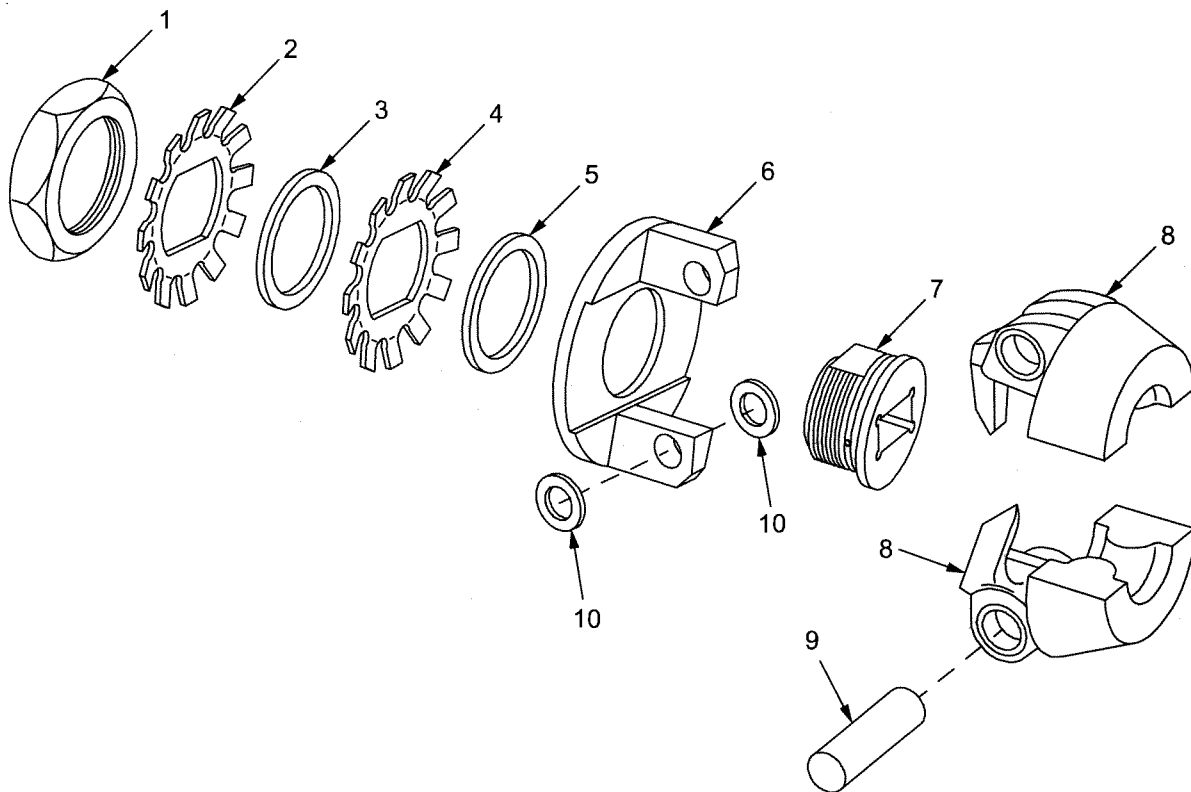
## RPSTL WORK PACKAGE - CONTINUED

0040 00

(1) ITEM NO	(2) SMR	(3) NSN	(4) CAGE	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODE (UOC)	(7) QTY
26	PAHZZ	2990-00-977-2591	6N299	4506994-5	WIRE BEARING PLATE.....	2
27	PAHHH	2910-00-871-5429	01843	LE9093A	LEVER ASSEMBLY, OPER.....	1
28	PAHZZ	5310-00-582-5965	80205	MS35338-44	.WASHER, LOCK PART OF KIT P/N 5705050.....	1
29	XAHZZ		01843	LE9083A	.LEVER, OPERATING.....	1
30	XAHZZ		01883	SC9043	.SCREW OPERATING LEVER.....	1
31	PAHZZ	5340-00-902-0426	96906	MS51938-6	.SEAL, ANTIPILFERAGE OPERATING LEVER NUT, PART OF KIT P/N 5705050.....	1
32	PAHZZ	5310-00-655-9484	10001	43N71918-10	.NUT, PLAIN, CASTELLAT OPERATING LEVER.....	1
33	KFHZZ		01843	BG8823	BEARING PLATE OPERATING LEVER, PART OF KIT P/N 5705050.....	1
34	PAHZZ	5330-00-406-7316	01843	GA9031	GASKET PART OF KIT P/N 5705050.....	1
35	PAHZZ	5360-00-785-6345	19207	7383472	SPRING, HELICAL, TORS PART OF KIT P/N 5705050, 5702632.....	1
36	KFHZZ		01843	PL8832A	PLATE ASSEMBLY, SPR OPERATING LEVER. PART OF KIT P/N 5705050.....	1
37	PAHZZ	5330-00-583-3473	01843	GA1144	PACKING, PREFORMED PART OF KIT P/N 5705050.....	1
38	PAHZZ	5330-00-310-6559	01843	GA401346	GASKET PART OF KIT P/N 5705050.....	1
39	PAHZZ	3040-01-265-4021	01843	SH8834A	SHAFT ASSEMBLY, OPER PART OF KIT P/N 5705050, 5702632.....	1
40	PAHZZ	2910-00-886-5371	01843	SC400-698	RIVET, DRIVE IDENTIFICATION PLATE...	2
41	XAHZZ		01843	NP904	PLATE, IDENTIFICATIO.....	1

END OF FIGURE





011055

Figure 6. Weight and Spider Assembly.

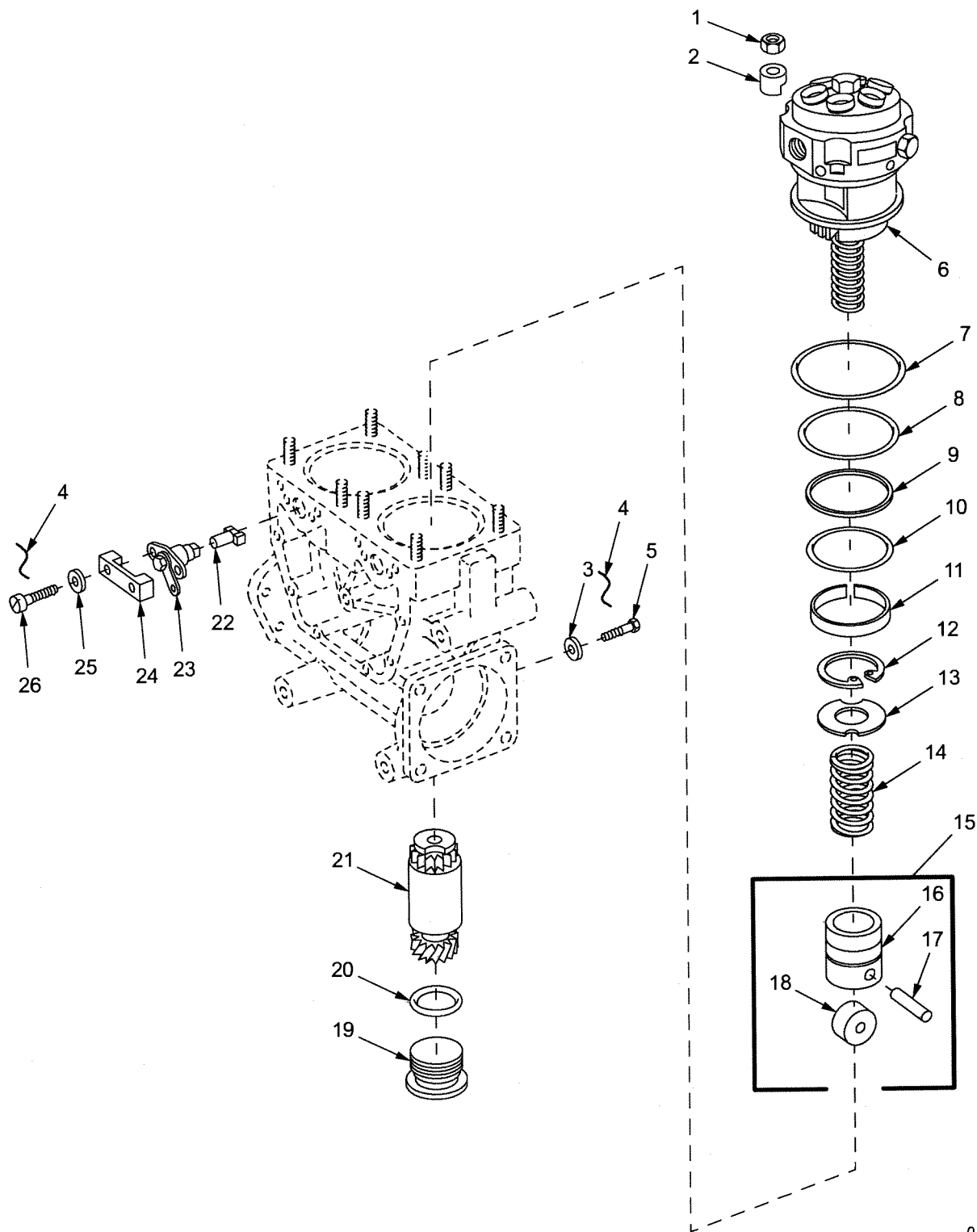


## RPSTL WORK PACKAGE - CONTINUED

0040 00

(1) ITEM NO	(2) SMR	(3) NSN	(4) CAGE	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODE (UOC)	(7) QTY
					GROUP 0302 FUEL PUMP FIGURE 6 WEIGHT AND SPIDER ASSEMBLY	
1	XAHZZ		01843	NT1261	NUT,ADJUSTING HUB.....	1
2	KFHZZ		01843	DC797	DISK OUTER,PART OF KIT P/N 5704369.	1
3	PAHZZ	5365-00-274-9575	01843	SR402771	SPACER,RING PART OF KIT P/N 5704369.	1
4	KFHZZ		01843	DC796	DISK INNER,PART OF KIT P/N 5704369.	1
5	PAHZZ	5365-00-595-6388	01843	SR402773	SPACER,RING 0.065 IN THK,PART OF KIT P/N 5704369.....	1
5	PAHZZ	5365-00-595-5318	01843	SR794-2	SPACER,RING 0.049 IN THK,PART OF KIT P/N 5704369.....	1
5	PAHZZ	5365-00-951-4318	01843	SR794-4	SPACER,RING 0.020 IN THK,PART OF KIT P/N 5704369.....	1
5	PAHZZ	5365-01-158-6753	01843	SR794-5	SPACER,RING 0.015 IN THK,PART OF KIT P/N 5704369.....	1
5	PAHZZ	5365-01-161-9993	01843	SR794-6	SPACER,RING 0.010 IN THK,PART OF KIT P/N 5704369.....	1
5	KFHZZ		01843	SR794-7	SPACER,RING 0.005 IN THK,PART OF KIT P/N 5704369.....	1
6	XAHZZ		01883	HP9025	SPIDER FRICTION DRIVE.....	1
7	XAHZZ		01843	HB9036	HUB FRICTION DRIVE.....	1
8	XAHZZ		01843	WT9027A	WEIGHT ASSEMBLY GOVERNOR.....	2
9	PAHZZ	5315-01-164-0635	01843	PN402687	UOC:B, PIN,WEIGHT.....	2
10	PAHZZ	5310-00-038-0751	01843	WA1448-1	WASHER,FLAT 0.036 IN THK,GOVERNOR WEIGHT PIN.....	1
10	PAHZZ	5310-00-038-0752	01843	WA1448-2	WASHER,FLAT 0.038 IN THK,GOVERNOR WEIGHT PIN.....	1
10	PAHZZ	5310-00-038-0753	01843	WA1448-3	WASHER,FLAT 0.040 IN THK,GOVERNOR WEIGHT PIN.....	1
10	PAHZZ	5310-00-038-0755	01843	WA400108	WASHER,FLAT 0.048 IN THK,GOVERNOR WEIGHT PIN.....	1
10	PAHZZ	5310-00-166-1412	0AHP5	27D123	WASHER,FLAT 0.044 IN THK,GOVERNOR WEIGHT PIN.....	1

END OF FIGURE



011068

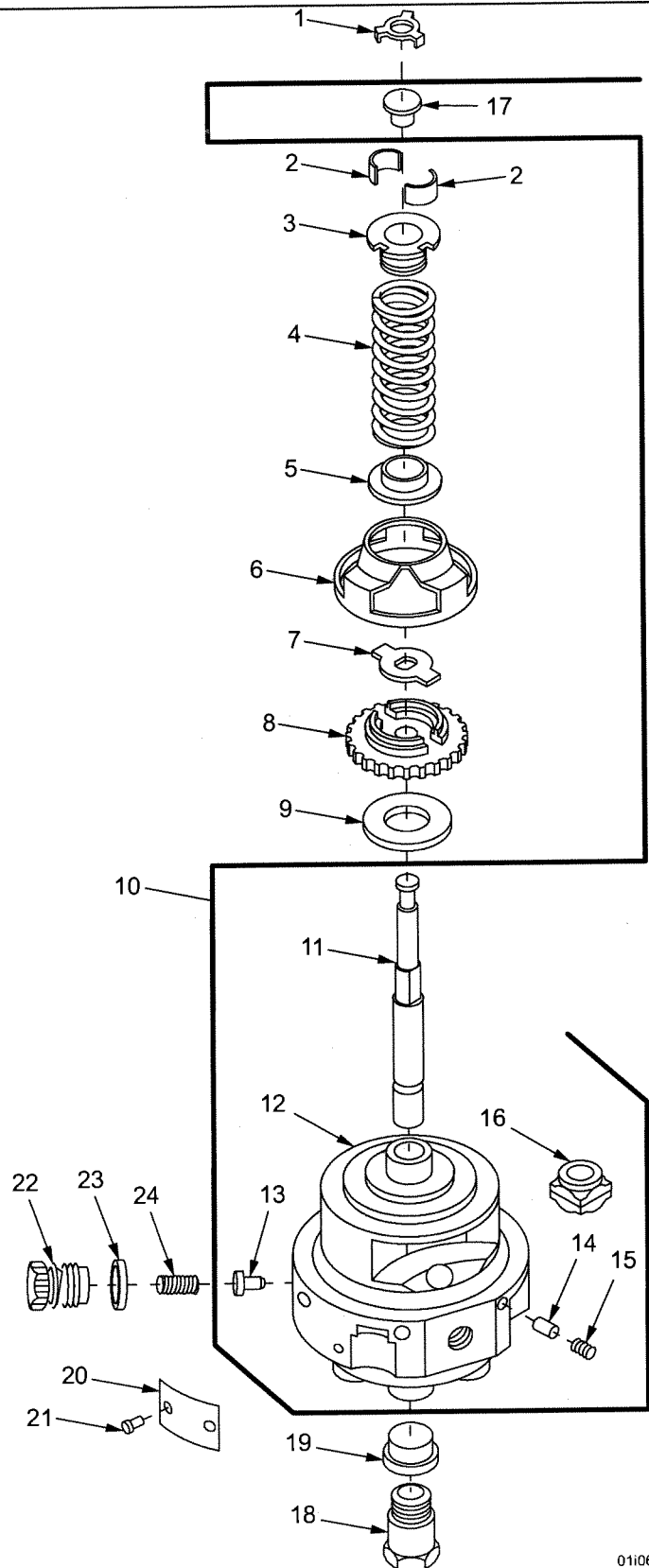
Figure 7. Head Assembly, Tappet Assembly, Gear Shaft Assembly, Control Unit Assembly and Associated Parts.

## RPSTL WORK PACKAGE - CONTINUED

0040 00

(1) ITEM NO	(2) SMR	(3) NSN	(4) CAGE	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODE (UOC)	(7) QTY
					GROUP 0302 FUEL PUMP FIGURE 7 HEAD ASSEMBLY, TAPPET ASSEMBLY, GEAR SHAFT ASSEMBLY, CONTROL UNIT ASSEMBLY AND ASSOCIATED PARTS	
1	PAHZZ	5310-00-880-7746	96906	MS51968-5	NUT, PLAIN, HEXAGON PUMP HEAD TO PUMP HOUSING.....	8
2	XAHHZ		01843	SV888	UOC: A, B, SPACER, RETAINING RI PUMP HEAD TO PUMP HOUSING.....	8
3	PAHZZ	5310-00-599-5616	01843	GA401271	UOC: A, B, WASHER, FLAT QUILL GEAR SHAFT RETAINING BOLT, PART OF KIT P/N 5702632.....	2
4	PAHZZ	2990-00-977-2591	6N299	4506994-5	WIRE BEARING PLATE GEARSHAFT ASSEMBLY (1) CONTROL UNIT ASSEMBLY (2).....	3
5	PAHZZ	5306-00-816-5803	01843	SC1110	BOLT, MACHINE QUILL GEAR SHAFT RETAINING.....	2
6	PAHHZ	2910-00-722-3536	19207	7748811	HEAD ASSEMBLY, FUEL SEE FIGURE 8 FOR PARTS BREAKOUT.....	2
6	PAHHH		01843	HD410304	UOC: B, HEAD ASSEMBLY, "11MM".....	
7	PAHZZ	5330-00-608-6432	96906	MS28775-237	UOC: A, PACKING, PREFORMED PART OF KIT P/N 5702632.....	2
8	PAHZZ	5330-00-576-9733	96906	MS28775-234	PACKING, PREFORMED PART OF KIT P/N 5702632.....	2
9	PAHZZ	5365-00-785-6355	02978	676679	SPACER, RING HEAD ASSEMBLY.....	2
10	PAHZZ	5330-00-982-4259	96906	MS28775-230	PACKING, PREFORMED HEAD ASSEMBLY, PART OF KIT P/N 5702632.....	2
11	PAHZZ	4310-01-353-8446	01843	RG882	RING, PISTON HEAD ASSEMBLY.....	2
12	PAHZZ	5365-00-804-2774	96906	MS16625-1212	RING, RETAINING TAPPET SPRING.....	2
13	XDHZZ	2910-00-247-6774	01843	GU887	SEAT, TAPPET SPRING OUTER.....	2
14	PAHZZ	5340-00-785-6360	01843	SP8819	UOC: A, B, SPRING, HELICAL, COMP TAPPET.....	2
15	PAHZZ	2910-00-785-6350	01843	TP881A	UOC: A, B, TAPET ASSEMBLY, FUE.....	2
16	XAHHZ		01843	GU888A	UOC: A, B, .GUIDE ASSEMBLY.....	2
17	XAHHZ		01843	PN8824	UOC: A, B, .PIN, ROLLER.....	2
18	XAHHZ		01843	RL883A	UOC: A, B, .ROLLER.....	2
19	XAHHZ		01843	PG887	UOC: A, B, PLUG, QUILL SHAFT.....	2
20	PAHZZ	5330-00-584-0263	96906	MS28775-218	PACKING, PREFORMED QUILL SHAFT PLUG PART OF KIT P/N 5702632.....	2
21	PAHZZ		01843	SH8821A	GEARSHAFT ASSEMBLY QUILL SEE FIGURE 8 FOR PARTS BREAKOUT.....	2
22	PAHZZ	5315-00-785-6352	01843	PN9023	PIN, SHOULDER, HEADLE CONTROL UNIT...	2
23	PAHZZ	2910-00-786-0191	01843	CU881A	CONTROL UNIT ASSEMB FUEL SEE FIGURE 9 FOR PARTS BREAKOUT.....	2
24	XAHHZ		01843	RN887	UOC: A, B, RETAINER CONTROL UNIT ASSEMBLY.....	2
25	PAHZZ	5310-01-022-8946	01843	WA406076	WASHER, LOCK. CONTROL UNIT RETAINER.	4
26	XAHHZ		01843	SC8817	SCREW CONTROL UNIT RETAINER.....	4

END OF FIGURE



01i069

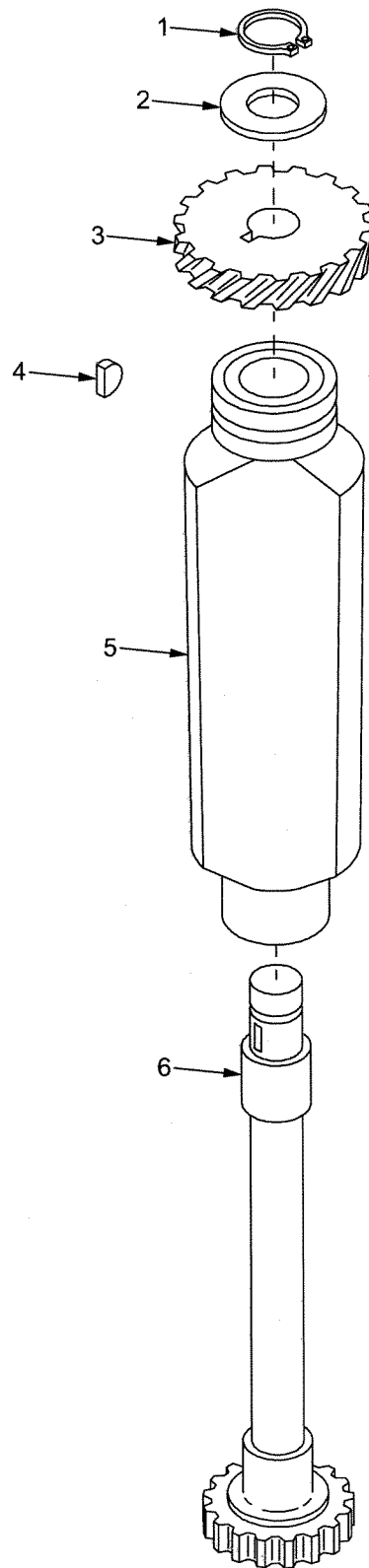
Figure 8. Hydraulic Head Assembly.

## RPSTL WORK PACKAGE - CONTINUED

0040 00

(1) ITEM NO	(2) SMR	(3) NSN	(4) CAGE	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODE (UOC)	(7) QTY
					GROUP 0302 FUEL PUMP FIGURE 8 HYDRAULIC HEAD ASSEMBLY	
1	PAHZZ			01843 RC883	RING,BUTTON,RETAINI.....	2
2	XAHZZ			01843 HP885	LOCK,PLUNGER.....	4
3	XAHZZ			01843 GU8810	SEAT,SPRING LOWER.....	2
4	PAHZZ			01843 SP8821	SPRING,HELICAL,COMP TAPPET.....	2
5	XAHZZ			01843 GU889	SEAT,SPRING UPPER.....	2
6	XAHZZ			01843 RN889	RETAINER,SPUR GEAR.....	2
7	PAHZZ	5340-00-786-0186		01843 GU8812	BRACKET,MOUNTING. PLUNGER GUIDE....	2
8	XAHZZ			01843 GE882	GEAR,SPUR.....	2
9	XAHZZ			01843 WA1804	WASHER,THRUST SPUR GEAR.....	2
10	XAHZZ			01843 HD410303	HEAD HYDRAULIC ASSEMBLY.....	2
					UOC:A,	
10	XAHZZ			01843 HD8822A	HEAD,HYDRAULIC ASSEMBLY.....	2
					UOC:B,	
11	XAHZZ			01843 PC885	PLUNGER.....	2
12	XAHZZ			01843 HD8815	HEAD,HYDRAULIC.....	2
13	XAHZZ			01843 VA885	VALVE,DELIVERY.....	2
14	XAHZZ			01843 PC889	.PLUG,SEALING.....	12
15	XAHZZ			01843 SC1961	.SETSCREW SEALING PLUG.....	12
16	XAHZZ			01843 SV887	.SLEEVE,PLUNGER.....	2
17	PAHZZ			01843 B0881	BUTTON,PLUNGER.....	2
					UOC:A,B,	
18	XAHZZ			01843 SC8813	SCREW,PLUNGER BORE.....	2
					UOC:B,	
18	XAHZZ			01843 SC8829	SCREW,PLUNGER BORE.....	2
					UOC:A,	
18	PAHZZ			01843 GA409963	GASKET,PLUNGER BORE SCREW.....	2
					UOC:A,	
19	PAHZZ	5330-01-433-8436		01843 GA410154	GASKET,PLUNGER BORE SCREW.....	2
					UOC:B,	
20	XAHZZ			01843 NP409942	PLATE,IDENTIFICATIO.....	2
					UOC:A,	
20	XAHZZ			01843 NP906	PLATE,IDENTIFICATION.....	2
					UOC:B,	
21	PAHZZ	2910-00-886-5371		01843 SC400-698	RIVET,DRIVE.....	4
22	XAHZZ			01843 SC8815	SCREW,DELIVERY VALV.....	2
					UOC:B,	
22	XAHZZ			01843 SC8828	SCREW,DELIVERY VALV.....	2
					UOC:A,	
23	PAHZZ	5330-01-433-8434		01843 GA9035	GASKET PART OF KIT P/N 5702632.....	2
					UOC:A,	
24	PAHZZ	5340-00-785-6339		01843 SP8820	SPRING,HELICAL,COMP DELIVERY VALVE.	2

END OF FIGURE



01i056

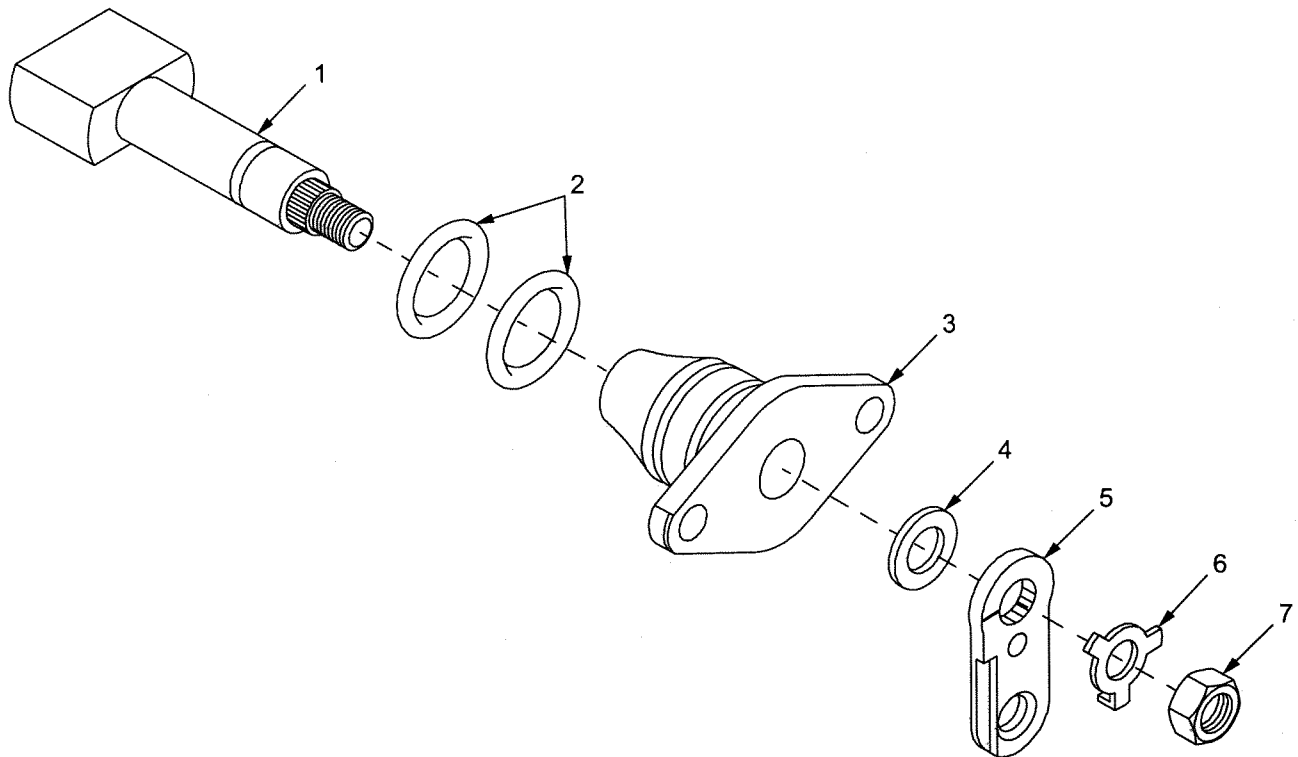
Figure 9. Gear Shaft Assembly.

RPSTL WORK PACKAGE - CONTINUED

0040 00

(1) ITEM NO	(2) SMR	(3) NSN	(4) CAGE	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODE (UOC)	(7) QTY
					GROUP 0302 FUEL PUMP FIGURE 9 GEAR SHAFT ASSEMBLY	
1	PAHZZ	5365-00-715-1152	96906	MS16624-1037	RING,RETAINING QUILL SHAFT GEAR....	2
2	XAHZZ		01843	SR888	SPACER,RETAINING RI.....	2
3	XAHZZ		01843	GE881	GEAR,HELICAL.....	2
4	PAHZZ	5315-00-687-5218	96906	MS35756-3	KEY,WOODRUFF.....	2
5	XAHZZ		01843	BG8813A	BUSHING ASSEMBLY.....	2
6	XAHZZ		01843	SH8821A	SHAFT.....	2

END OF FIGURE



01i053

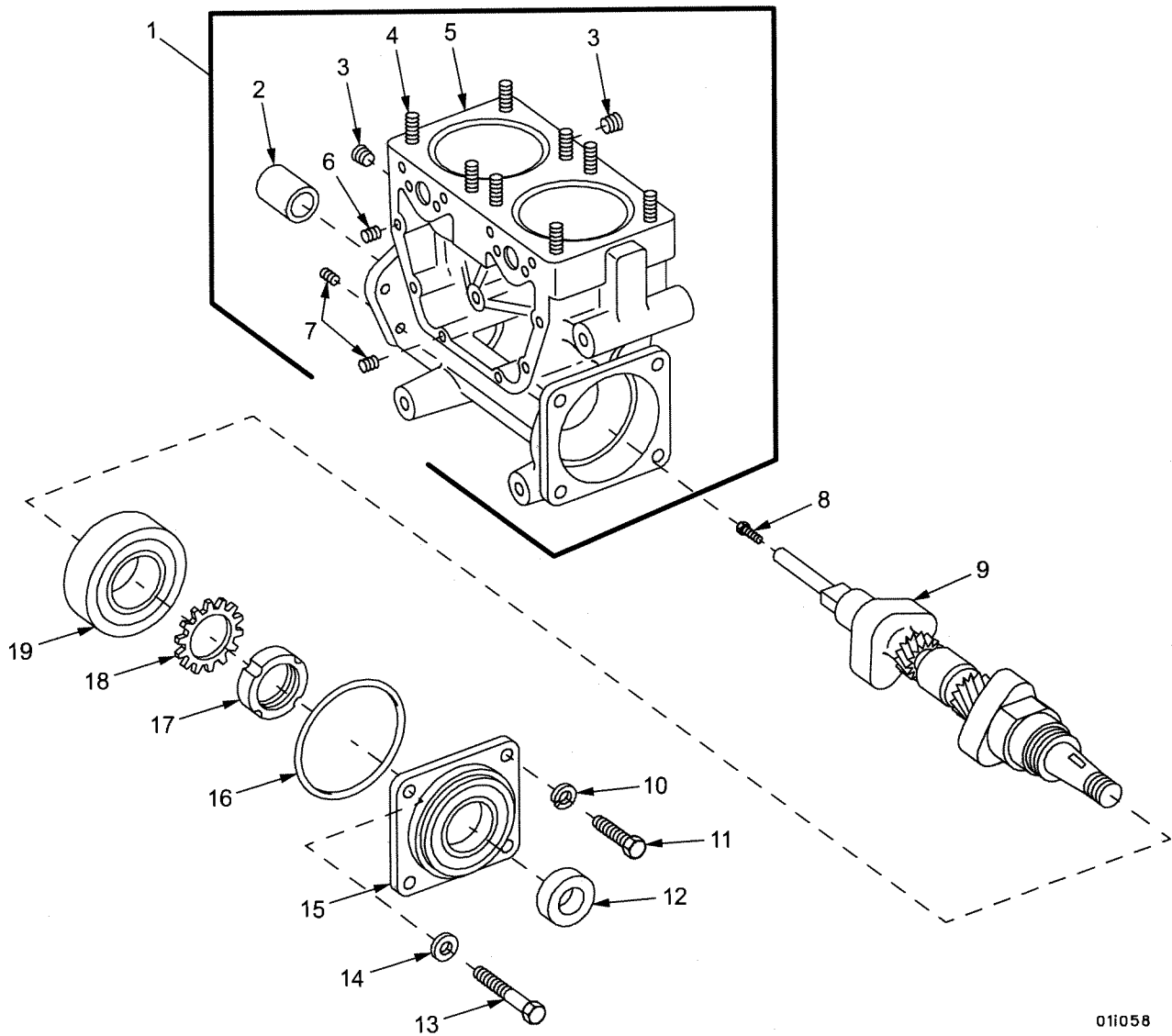
Figure 10. Control Unit Assembly.



## RPSTL WORK PACKAGE - CONTINUED

0040 00

(1) ITEM NO	(2) SMR	(3) NSN	(4) CAGE	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODE (UOC)	(7) QTY
					GROUP 0302 FUEL PUMP FIGURE 10 CONTROL UNIT ASSEMBLY	
1	XAHZZ		01843	SH8823	SHAFT.....	2
2	PAHZZ	5330-00-618-1920	96906	MS28775-017	UOC:A,B, PACKING,PREFORMED CONTROL UNIT PART OF KIT P/N 5702632,5702765.....	4
3	XAHZZ		01843	BC8810	BUSHING.....	2
4	KFHZZ		01843	SR8813	SPACER CONTROL UNIT LEVER PART OF KIT P/N 5702765.....	2
5	XAHZZ		01843	LE8831	LEVER,CONTROL UNIT.....	2
6	PAHZZ	5310-01-022-8861	01843	WA1648	WASHER,KEY CONTROL UNIT LEVER TO PART OF KIT P/N 5702765.....	2
7	XAHZZ		01843	NT1264	NUT,JAM CONTROL UNIT LEVER TO SHAFT	2
				END OF FIGURE		



01i058

Figure 11. Housing, Camshaft, Plate and Associated Parts

## RPSTL WORK PACKAGE - CONTINUED

0040 00

(1) ITEM NO	(2) SMR	(3) NSN	(4) CAGE	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODE (UOC)	(7) QTY
					GROUP 0302 FUEL PUMP	
					FIGURE 11 HOUSING,CAMSHAFT,PLATE AND ASSOCIATED PARTS	
1	PFHHH	4320-01-146-1911	01843	HG8815A	HOUSING,LIQUIP PUMP.....	1
2	PAHZZ	3120-00-133-6755	19207	11662505	.BEARING,SLEEVE CAMSHAFT.....	1
3	PAHZZ	4730-00-964-7548	21450	444683	.PLUG,PIPE OIL GALLERY.....	2
4	PAHZZ	5307-00-596-8378	01843	SD881	.STUD INJECTION PUMP HOUSIG.....	8
5	XAHZZ		01843	HG8820C	.HOUSING,INJECTION P.....	1
6	PAHZZ		01843	IT403589	.HELICOIL,.25-20 X .50 UNC-2B USED ON ALL PUMPS BEGINNING WITH S/N 8F7790 & HIGHER.....	8
7	PAHZZ		01843	IT412663	.HELICAL,.25-20 X .25 UNC-2B USED ON ALL PUMPS BEGINNING WITH S/N 8F7790 & HIGHER.....	6
8	PAHZZ	5305-00-281-6384	01843	SC1149	SCREW,ASSEMBLED WAS CAMSHAFT.....	1
9	PAHZZ	2910-00-785-6344	01843	SH8824	CAMSHAFT,PUMP FUEL.....	1
10	PAHZZ	5310-00-637-9541	96906	MS38338-46	WASHER,LOCK.....	3
11	PAHZZ	5305-00-269-3213	80205	MS90725-62	SCREW,CAP,HEXAGON H.....	3
12	PAHZZ	5330-00-812-6435	80201	43547A	SEAL,PLAIN ENCASED PART OF KIT P/N 5702632.....	1
13	XAHZZ		01843	SC8818	SCREW BEARING RETAINING PLATE TO PUMP HOUSING.....	1
14	XAHZZ		01843	WA5-14BL	WASHER BEARING RETAINING PLATE TO PUMP HOUSING.....	1
15	XAHZZ		01843	PL8823	PLATE,BEARING RETAI CAMSHAFT.....	1
16	PAHZZ	5330-00-618-1603	96906	MS28775-240	PACKING,PREFORMED BEARING RETAINING PLATE PART OF KIT P/N 5702632.....	1
17	PAHZZ	5310-00-208-3447	96906	MS172244	NUT,PLAIN,ROUND BEARING RETAINING..	1
18	PAHZZ	5310-00-566-8871	96906	MS172209	WASHER,KEY BEARING RETAINING NUT...	1
19	PAHZZ	3110-00-554-5968	26385	BCA1308	BEARING,BALL,ANNULA CAMSHAFT.....	1

END OF FIGURE



## RPSTL WORK PACKAGE - CONTINUED

0040 00

(1) ITEM NO	(2) SMR	(3) NSN	(4) CAGE	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODE (UOC)	(7) QTY
					GROUP 94 REPAIR KITS GROUP 9401 REPAIR KITS FIGURE KITS REPAIR KITS	
PAHZZ	5330-00-786-5239	19207	5702632		GASKET AND PREFORME PART OF KIT P/N E8CR100-013.....	1
PAHZZ	5365-00-786-5238	19207	5702638		SHIM SET GOVERNOR SPRINGS..... UOC:A,C,	1
PAFZZ	4330-00-801-1154	19207	5702739		PARTS KIT,FLUID PRE PART OF KIT P/N E8CR100-013.....	1
					PACKING,PREFORMED ( 1) 2-7 FILTER ELEMENT ( 1) 2-8	
PAHZZ	2910-00-221-4809	19207	5702765		PARTS KIT,METERING PART OF KIT P/N E8CR100-013.....	1
PAHZZ	4330-00-134-4733	19207	5704356		PARTS KIT,FLUID PRE PART OF KIT P/N E8CR100-013.....	1
					NUT,CAP ( 2) 2-1 PACKING,PREFORMED ( 4) 2-3 FILTER ASSEMBLY ( 1) 2-4	
PAHZZ	2910-00-407-2618	19207	5704369		PARTS KIT,METERING PART OF KIT P/N E8CR100-013.....	1
					DISK ( 1) 6-2 DISK ( 1) 6-4 SPACER,RING ( 1) 6-5 SPACER,RING ( 1) 6-5 SPACER,RING ( 1) 6-5 SPACER,RING ( 1) 6-5 SPACER,RING ( 1) 6-5	
PAHZZ	2910-01-043-8182	19207	5705050		PARTS KIT,FUEL INJE PART OF KIT P/N E8CR100-013.....	1
					WASHER,LOCK ( 10) 3-2 NUT,PLAIN,HEXAGON ( 2) 5-21 SETSCREW ( 2) 5-22 SEAL,ANTIPIILFERAGE ( 1) 5-23 SCREW,CAP,HEXAGON H( 4) 5-25 BEARING PLATE ( 1) 5-33 SPRING,HELICAL,TORS( 1) 5-35 PACKING,PREFORMED ( 1) 5-36 LEVER,MANUAL CONTRO( 1)	
PAHZZ	2910-01-050-2520	19207	5705051		PARTS KIT,FUEL INJE PART OF KIT P/N E8CR100-013.....	1
					WASHER,LOCK ( 10) 3-2 NUT,PLAIN,HEXAGON ( 1) 4-27 SPACER ( 1) 5-6 SPACER ( 1) 5-6	

END OF FIGURE

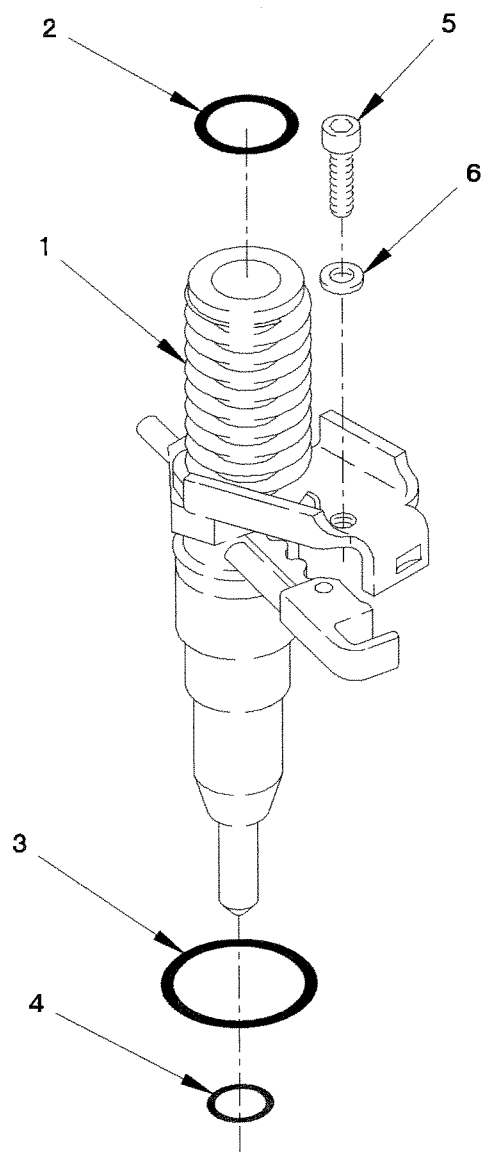
**CATERPILLAR UNIT INJECTOR**

**LMTV 5 TON TRUCK**

**MTV 2.5 TRUCK**

**STRYKER LIGHT ARMORED VEHICLE**

1 — 2  
THROUGH  
4



A301A-1A

FIGURE 25. FUEL INJECTOR

## SECTION II

TM 9-2320-366-24P-1

(1)	(2)	(3)	(4)	(5)	(6)
ITEM	SMR		PART	DESCRIPTION AND	
NO	CODE	CAGEC	NUMBER	USABLE ON CODE (UOC)	QTY

GROUP 0301: CARBURETOR, FUEL INJECTOR  
FIG.25 FUEL INJECTOR

1	PAFZZ	11083	4P2995	INJECTOR ASSEMBLY, F.....	6
2	PAFZZ	11083	1P8116	.O-RING.....	1
3	PAFZZ	11083	114-8718	.PACKING, PREFORMED.....	1
4	PAFZZ	11083	125-8274	.O-RING.....	1
5	PAFZZ	11083	8T8442	SCREW,CAP, SOCKET HE M6 X 1 X 30....	6
6	PAFZZ	11083	9X8267	WASHER, FLAT.....	6

END OF FIGURE

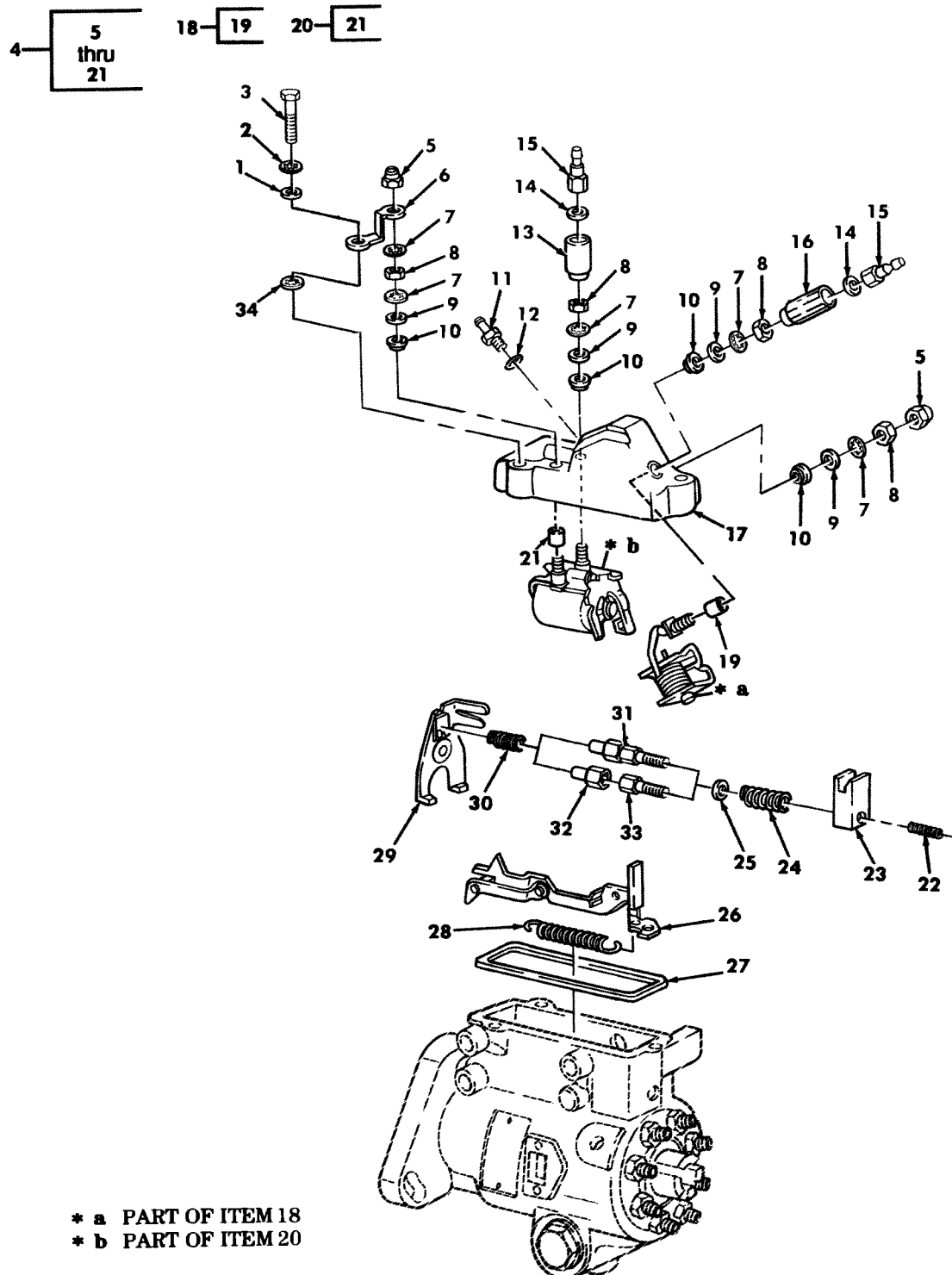


**STANADYNE ROTARY PUMP**

**HMMWV SERIES TRUCKS**

**DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE  
REPAIR PARTS AND SPECIAL TOOLS LIST**

**ENGINE DIESEL: 8 CYLINDER, NATURALLY ASPIRATED, DETUNED, 6.5 LITER**  
**ENGINE DIESEL: 8 CYLINDER, NATURALLY ASPIRATED, 6.2 AND 6.5 LITER**  
**ENGINE DIESEL: 8 CYLINDER, TURBOCHARGED, 6.5 LITER**



*Figure 20. Fuel Injection Pump Cover Assembly, Governor Linkage, and Related Parts.*

(1)	(2)	(3)	(4)	(5)	(6)	(7)
ITEM	SMR			PART	DESCRIPTION AND USABLE ON CODES (UOC)	QTY
NO	CODE	NSN	CAGEC	NUMBER		
GROUP 0302 FUEL PUMP						
FIG. 20 FUEL INJECTION PUMP COVER ASSEMBLY, GOVERNOR LINKAGE, AND RELATED PARTS						
1	PAFZZ	5310008411131	00198	3001564	WASHER, FLAT.....	3
2	PAFZZ	5310012139964	84760	11582	WASHER, LOCK.....	3
3	PAFZZ	5305011184114	84760	22351	SCREW, MACHINE.....	3
4	AFFFF		34623	5569831-C	COVER ASSEMBLY, FUEL.....	1
5	PAFZZ	5310005825765	03350	22FT832	.NUT, SELF-LOCKING, HE PART OF KIT P/N 26431.....	2
6	PAFZZ	2920011173251	84760	20951	.LEAD, IGNITION, ENGIN PART OF KIT P/N 26431.....	1
7	PAFZZ	5310005590070	96906	MS35333-38	.WASHER, LOCK PART OF KIT P/N 26431..	5
8	PAFZZ	5310009349757	96906	MS35649-282	.NUT, PLAIN, HEXAGON PART OF KIT P/N 26431.....	4
9	PAFZZ	5310001900752	22787	10-9858	.WASHER, FLAT PART OF KIT P/N 26431..	4
10	PAFZZ	5310008307825	84760	12500	.WASHER, SHOULDERED PART OF KIT P/N 26431.....	4
11	PAFZZ	4820011659596	84760	23183	.VALVE, CHECK.....	1
12	PAFZZ	5331012322145	0CTH1	3921936	.O-RING PART OF KIT P/N 30405.....	1
13	PAFZZ	2920011883259	84760	27010	.HOUSING, TERMINAL.....	1
14	PAFZZ	5310011910440	84760	27009	.WASHER, FLAT.....	2
15	PAFZZ	5940011851122	84760	27008	.TERMINAL, STUD.....	2
16	PAFZZ	2530011949868	84760	27065	.BOOT, VEHICULAR COM.....	1
17	PAFZZ	5340012503240	84760	27014	.COVER, ACCESS.....	1
18	PAFZZ	5945011903559	84760	27007	.SOLENOID, ELECTRICAL COLD AVANCE...	1
19	PFFZZ	4710012305611	84760	23190	..TUBE, INSULATING PART OF KIT P/N 30405.....	2
20	PAFZZ	5945011883194	84760	27011	.SOLENOID, ELECTRICAL FUEL SHUTOFF..	1
21	PFFZZ	4710012305611	84760	23190	..TUBE, INSULATING PART OF KIT P/N 30405.....	2
22	PAFZZ	5360013178098	84760	23744	SPRING, HELICAL, COMP 6.2 LITER, USE WITH PUMP ASSEMBLY P/N DB2829-4879 AND ALL 6.5 LITER.....	1
23	PAHZZ	2910011883254	84760	21763	BLOCK, PUMP, INJECTIO 6.2 LITER, USE WITH PUMP ASSEMBLY P/N DB2829-4523.. UOC: H11, H13, H14, H15, H16, H17, H18, H20, H21, H24, H25, H26, H27, H28, MMM	1
23	PAFZZ	2910013162312	84760	24880	BLOCK ASSEMBLY, GOVE 6.2 LITER, USE WITH PUMP ASSEMBLY P/N DB2829-4879 AND ALL 6.5 LITER.....	1
24	PAHZZ	5360011893606	84760	27005	SPRING, HELICAL, COMP 6.2 LITER, USE WITH PUMP ASSEMBLY DB2829-4523..... UOC: H11, H13, H14, H15, H16, H17, H18, H20, H21, H24, H25, H26, H27, H28, MMM	1
24	PAHZZ	5360013181893	84760	28397	SPRING, HELICAL, COMP 6.2 LITER, USE WITH PUMP ASSEMBLY P/N DB2829-4879 AND ALL 6.5 LITER.....	1
25	PAFZZ	5310011886743	84760	22325	WASHER, FLAT.....	1
26	PAFZZ	2910011892142	84760	18021	HOOK ASSEMBLY, GOVER.....	1
27	PAHZZ	5330012342615	0CTH1	3921950	GASKET PART OF KIT P/N 30405.....	1

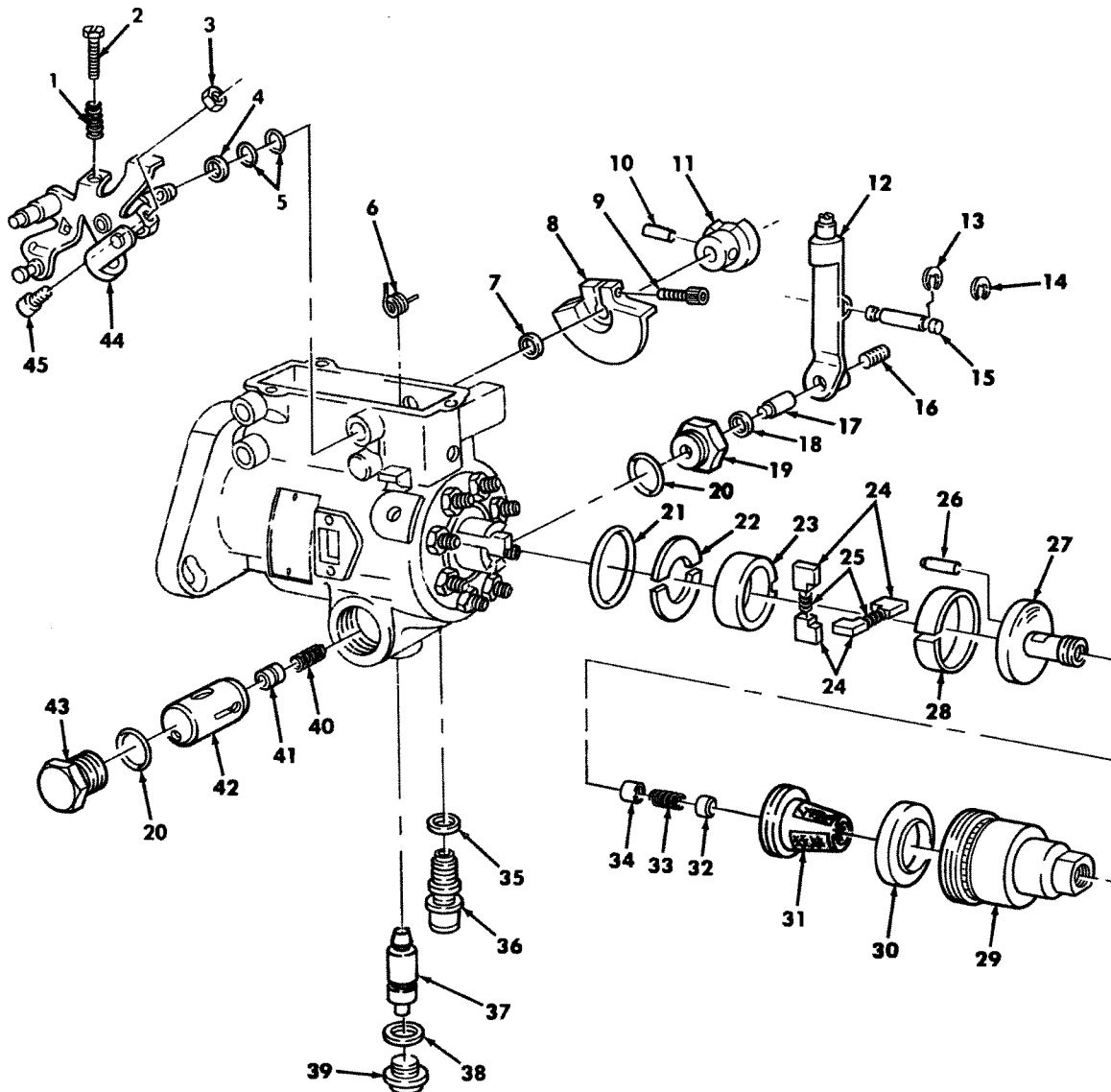
SECTION II			TM9-2815-237-34P		0021 00	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
ITEM	SMR			PART		
NO	CODE	NSN	CAGEC	NUMBER	DESCRIPTION AND USABLE ON CODES(UOC)	QTY
28	PAHZZ	5360003359327	84760	11919	SPRING,HELICAL,EXTE.....	1
29	PAFZZ	2520011883282	84760	23461	SHIFTER FORK.....	1
30	PAFZZ	5360014137363	84760	30776	SPRING,HELICAL,COMP 6.5 LITER.....	1
30	PAHZZ	5360011880807	84760	22125	SPRING,HELICAL,COMP 6.2 LITER.....	1
					UOC:AVY,A11,A13,A14,A15,A20,A24,A25, A26,A27,B16,B17,B18,HVY,H11,H13,H14, H15,H16,H17,H18,H20,H21,H24,H25,H26, H27,H28,MMM	
31	PAFZZ	3040013170367	84760	23610	CONNECTING LINK,RIG 6.2 LITER,USE WITH PUMP ASSEMBLY P/N DB2829-4879 AND ALL 6.5 LITER.....	1
32	PAFZZ	2910011883252	84760	22327	SLEEVE,ADJUSTING,GO 6.2 LITER,USE WITH PUMP ASSEMBLY P/N DB2829-4523.. UOC:H11,H13,H14,H15,H16,H17,H18,H20, H21,H24,H25,H26,H27,H28,MMM	1
33	PAFZZ	2910012569157	84760	27927	RETAINER,HELICAL CO 6.2 LITER,USE WITH PUMP ASSEMBLY P/N DB2829-4523.. UOC:H11,H13,H14,H15,H16,H17,H18,H20, H21,H24,H25,H26,H27,H28,MMM	1
34	PAFZZ	5310011182248	84760	18493	WASHER,LOCK PART OF KIT P/N 26431...	1

END OF FIGURE



**DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE  
REPAIR PARTS AND SPECIAL TOOLS LIST**

**ENGINE DIESEL: 8 CYLINDER, NATURALLY ASPIRATED, DETUNED, 6.5 LITER**  
**ENGINE DIESEL: 8 CYLINDER, NATURALLY ASPIRATED, 6.2 AND 6.5 LITER**  
**ENGINE DIESEL: 8 CYLINDER, TURBOCHARGED, 6.5 LITER**



*Figure 21. Fuel Injection Pump Throttle Shaft, Regulator, Transfer Pump, and Related Parts.*

TM9-2815-237-34P					0022 00
(1)	(2)	(3)	(4)	(5)	(7)
ITEM	SMR			PART	
NO	CODE	NSN	CAGEC	NUMBER	DESCRIPTION AND USABLE ON CODES (UOC) QTY
GROUP 0302 FUEL PUMP					
FIG. 21 FUEL INJECTION PUMP THROTTLE SHAFT, REGULATOR, TRANSFER PUMP, AND RELATED PARTS					
1	PAHZZ	5360011906215	84760	21358	SPRING, HELICAL, COMP..... 1
2	PAHZZ	5305012159425	84760	21646	SCREW..... 1
3	PAHZZ	5310009882652	96906	MS35650-103	NUT, PLAIN, HEXAGON #10-32..... 1
4	PAHZZ	5365011880993	84760	22900	SPACER, SLEEVE..... 1
5	PAHZZ	5331012159638	84760	24585	O-RING PART OF KIT P/N 30405..... 2
6	PAHZZ	5360013179451	84760	26181	SPRING, HELICAL, COMP 6.2 LITER, USE WITH PUMP ASSEMBLY DB2829-4879 AND ALL 6.5 LITER..... 1
7	PAHZZ	5365008774956	84760	14408	SHIM PART OF KIT P/N 30405..... 1
8	PAHZZ	2910011883256	84760	23428	CAM FACE, PUMP 6.2 AND 6.5 LITER DETUNED..... 1
8	PAHZZ	3040014459101	84760	29122	UOC:AVY, A11, A13, A14, A15, A20, A24, A25, A26, A27, B16, B17, B18, BVY, H11, H13, H14, H15, H16, H17, H18, H20, H21, H24, H25, H26, H27, H28, MMM CAM, CONTROL 6.5 LITER..... 1
9	PAHZZ	5305011905745	84760	22398	UOC:BVY, B15, B20, B24, B25, C17, NNN, XAA, XBB SCREW, MACHINE..... 1
10	PAHZZ	5315011675584	84760	21284	PIN, GROOVED, HEADLES PART OF KIT P/ N 30405..... 1
11	PAHZZ	3040011892163	84760	27006	CAM, CONTROL 6.2 AND 6.5 LITER DETUNED..... 1
12	PAHZZ	3040013170368	84760	28937	UOC:AVY, A11, A13, A14, A15, A20, A24, A25, A26, A27, B16, B17, B18, BVY, H11, H13, H14, H15, H16, H17, H18, H20, H21, H24, H25, H26, H27, H28, MMM, LEVER, REMOTE CONTRO 6.2 LITER, USE WITH PUMP ASSEMBLY P/N DB2829-4879 AND ALL 6.5 LITER..... 1
13	PAHZZ	5325011880962	84760	23566	RING, RETAINING PART OF KIT P/N 30405..... 2
14	PAHZZ	5325014137364	84760	30844	RING, RETAINING 6.5 LITER..... 2
15	PAHZZ	5315011900429	84760	22397	PIN, GROOVED, HEADLES..... 1
16	PAHZZ	5305012605737	84760	26087	SETSCREW..... 1
17	PAHZZ	5340011926030	84760	22917	PLUNGER, DETENT..... 1
18	PAHZZ	5330012338597	84760	27163	SEAL..... 1
19	PAHZZ	5365013174249	84760	28474	PLUG, MACHINE THREAD 6.2 LITER USE WITH PUMP ASSEMBLY DB2829-4879 AND ALL 6.5 LITER..... 1
19	PAHZZ	5365011880784	84760	22693	PLUG, MACHINE THREAD 6.2 LITER, USE WITH PUMP ASSEMBLY P/N DB2829-4523.. UOC:H11, H13, H14, H15, H16, H17, H18, H20, H21, H24, H25, H26, H27, H28, MMM SEAL, DRAIN PLUG PART OF KIT P/N 30405..... 2
20	PAHZZ	5330012332778	84760	27609	PACKING, PREFORMED PART OF KIT P/N 30405..... 1
21	PAHZZ	5330012360474	84760	27608	

SECTION II			TM9-2815-237-34P		0022 00	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
ITEM NO	SMR CODE	NSN	CAGEC	PART NUMBER	DESCRIPTION AND USABLE ON CODES(UOC)	QTY
22	PAHZZ	2910011890895	84760	20530	RETAINER, ROTOR, TRAN.....	2
23	PAHZZ	2910012321044	84760	22988	LINER, TRANSFER PUMP.....	1
24	PAHZZ	2910012309007	84760	20803	VANE, INJECTION PUMP..STANDARD.....	14
24	PAHZZ	2910001486555	84760	20804	BLADE, TRANSFER PUMP OVERSIZE, .001..	4
25	PAHZZ	5360009002564	84760	15699	SPRING, HELICAL, COMP.....	2
26	PAHZZ	5315011880495	84760	19837	PIN.....	1
27	PAHZZ	2910011883249	84760	21200	REGULATOR ASSEMBLY, 6.2 LITER, USE WITH PUMP ASSEMBLY P/N DB2829-4523..	1
					UOC: H11, H13, H14, H15, H16, H17, H18, H20, H21, H24, H25, H26, H27, H28, MMM	
27	PAHZZ	4810014159460	84760	28988	VALVE, REGULATING, FL 6.2 LITER, USE WITH PUMP ASSEMBLY P/N DB2829-4879 AND ALL 6.5 LITER.....	1
28	PAHZZ	5325011880960	84760	20528	RING, RETAINING.....	1
29	PAHZZ	2910011883251	84760	21296	CAP, TRANSFER PUMP 6.2 LITER, USE WITH PUMP ASSEMBLY P/N DB2829-4523..	1
					UOC: H11, H13, H14, H15, H16, H17, H18, H20, H21, H24, H25, H26, H27, H28, MMM	
29	PAHZZ	2910014140346	84760	28981	HOUSING, FUEL PUMP 6.2 LITER, USE WITH PUMP ASSEMBLY P/N DB2829-4879 AND ALL 6.5 LITER.....	1
30	PAHZZ	2910011883250	84760	20523	PLATE, PUMP PRESSURE 6.2 LITER, USE WITH PUMP ASSEMBLY P/N DB2829-4523..	1
					UOC: H11, H13, H14, H15, H16, H17, H18, H20, H21, H24, H25, H26, H27, H28, MMM	
31	PAHZZ	4730013340695	84760	23819	STRAINER ELEMENT, SE 6.2 LITER, USE WITH PUMP ASSEMBLY P/N DB2829-4523..	1
					UOC: H11, H13, H14, H15, H16, H17, H18, H20, H21, H24, H25, H26, H27, H28, MMM	
31	PAHZZ	2910013638782	84760	28986	SCREEN, FILTER, GOVER 6.2 LITER, USE WITH PUMP ASSEMBLY P/N DB2829-4879 AND ALL 6.5 LITER.....	1
32	PAHZZ	4730004596077	84760	15228	PLUG ASSEMBLY, END P.....	1
33	PAHZZ	5360011886693	78514	27003	SPRING, HELICAL, COMP 6.2 LITER, USE WITH PUMP ASSEMBLY P/N DB2829-4523..	1
					UOC: H11, H13, H14, H15, H16, H17, H18, H20, H21, H24, H25, H26, H27, H28, MMM	
33	PAHZZ	5360013181894	84760	23915	SPRING, HELICAL, COMP 6.2 LITER, USE WITH PUMP ASSEMBLY P/N DB2829-4879 AND ALL 6.5 LITER.....	1
34	PAHZZ	4820011890894	84760	19895	PISTON, VALVE.....	1
35	PAHZZ	5331012360472	0CTH1	3921940	O-RING PART OF KIT P/N 30405.....	1
36	PAHZZ	5305011886568	84760	24566	SCREW.....	1
37	PAHZZ	5315011892141	84760	23925	PIN, CAM ADVANCE.....	1
38	PAHZZ	5331012327886	0CTH1	3921939	O-RING PART OF KIT P/N 30405.....	1
39	PAHZZ	5365011880785	84760	23056	PLUG, MACHINE THREAD.....	1
40	PAHZZ	5360014166594	84760	29049	SPRING, HELICAL, COMP 6.2 LITER, USE WITH PUMP ASSEMBLY P/N DB2829-4523..	1
					UOC: H11, H13, H14, H15, H16, H17, H18, H20, H21, H24, H25, H26, H27, H28, MMM	
40	PAHZZ	5360011893607	84760	23601	SPRING, HELICAL, COMP 6.2 LITER, USE WITH PUMP ASSEMBLY P/N DB2829-4523..	1
					UOC: H11, H13, H14, H15, H16, H17, H18, H20,	



SECTION II			TM9-2815-237-34P		0022 00
(1)	(2)	(3)	(4)	(5)	(7)
ITEM	SMR			PART	
NO	CODE	NSN	CAGEC	NUMBER	DESCRIPTION AND USABLE ON CODES(UOC) QTY
40	PAHZZ	5360014137368	84760	28463	H21,H24,H25,H26,H27,H28,MMM SPRING,HELICAL,COMP 6.5 LITER..... 1
41	PAHZZ	2910011900069	84760	22367	VALVE,SERVO ADVANCE..... 1
42	PAHZZ	3040012470914	84760	26382	PISTON,LINEAR ACTUA STANDARD,6.2 LITER,USE WITH PUMP ASSEMBLY P/N DB2829-4523..... 1
42	PAHZZ	2910014146651	84760	29043	UOC:H11,H13,H14,H15,H16,H17,H18,H20, H21,H24,H25,H26,H27,H28,MMM PISTON,FUEL INJECTO STANDARD,6.2 LITER,USE WITH PUMP ASSEMBLY P/N DB2829-4879 AND ALL 6.5 LITER..... 1
42	PAHZZ	4320012563698	84760	26383	PISTON,PUMP .008 OVERSIZE,6.2 LITER,USE WITH PUMP ASSEMBLY P/N DB2829-4523..... 1
42	PAHZZ	2910014147888	84760	29042	UOC:H11,H13,H14,H15,H16,H17,H18,H20, H21,H24,H25,H26,H27,H28,MMM PISTON,FUEL INJECTO .002 OVERSIZE, 6.2 LITER,USE WITH PUMP ASSEMBLY P/N DB2829-4879 AND ALL 6.5 LITER..... 1
42	PAHZZ	4320014256571	84760	28457	PISTON,PUMP .005 OVERSIZE,6.2 LITER,USE WITH PUMP ASSEMBLY P/N DB2829-4523..... 1
42	PAHZZ	2910014459041	84760	29041	UOC:H11,H13,H14,H15,H16,H17,H18,H20, H21,H24,H25,H26,H27,H28,MMM INJECTION CONTROL,M .005 OVERSIZE, 6.2 LITER,USE WITH PUMP ASSEMBLY P/ N DB2829-4879 AND ALL 6.5 LITER..... 1
42	PAHZZ	2815014469537	84760	29040	PISTON,FUEL INJECTO .008 OVERSIZE, 6.2 LITER,USE WITH PUMP ASSEMBLY P/ N DB2829-4879 AND ALL 6.5 LITER..... 1
42	PAHZZ	4320011883258	84760	26989	PISTON,PUMP .002 OVERSIZE,6.2 LITER,USE WITH PUMP ASSEMBLY P/N DB2829-4523..... 1
43	PAHZZ	5365013181887	84760	22505	UOC:H11,H13,H14,H15,H16,H17,H18,H20, H21,H24,H25,H26,H27,H28,MMM PLUG,MACHINE THREAD 6.2 LITER,USE WITH PUMP ASSEMBLY P/N DB2829-4879 AND ALL 6.5 LITER..... 1
43	PAHZZ	5365011880783	84760	23426	PLUG,MACHINE THREAD 6.2 LITER,USE WITH PUMP ASSEMBLY P/N DB2829-4523.. UOC:H11,H13,H14,H15,H16,H17,H18,H20, H21,H24,H25,H26,H27,H28,MMM 1
44	PAFZZ	2910011891747	84760	24345	SHAFT ASSEMBLY,THRO..6.2 AND 6.5 N/A UOC:AVY,A11,A13,A14,A15,A20,A24,A25, A26,A27,BVY,B15,B16,B17,B18,B20,B24, B25,C17,HVY,H11,H13,H14,H15,H16,H17, H18,H20,H21,H24,H25,H26,H27,H28,MMM, NNN 1
44	PAFZZ	2815014368370	84760	31843	SHAFT,CONTROL ASSEM TURBO..... 1
45	PAFZZ	5305011904070	84760	21712	UOC:XAA,XBB SCREW,MACHINE 6.2 LITER..... 1
					UOC:H11,H13,H14,H15,H16,H17,H18,H20, H21,H24,H25,H26,H27,H28,MMM

TM9-2815-237-34P

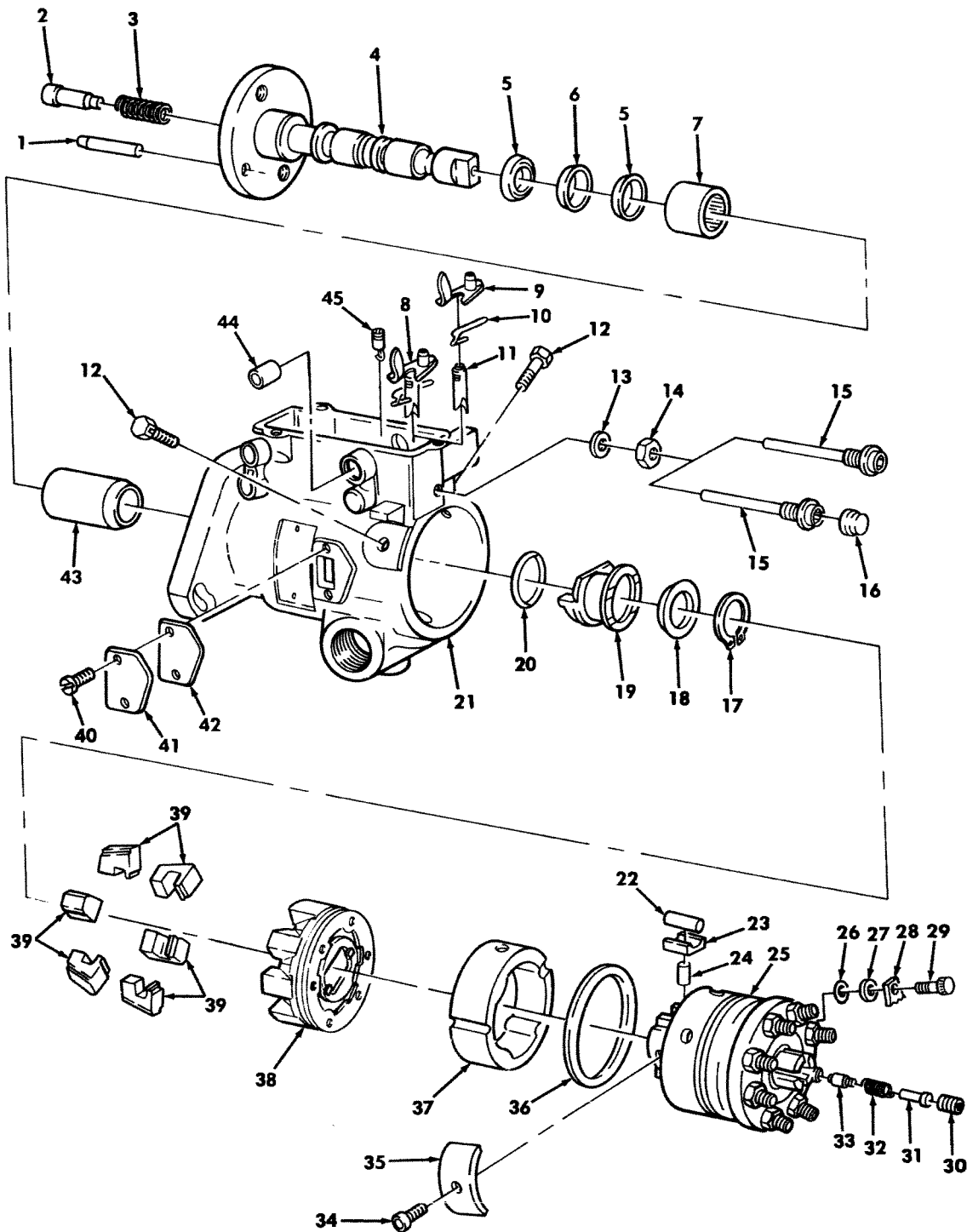
0022 00

(1) ITEM NO	(2) SMR CODE	(3) NSN	(4) CAGEC	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODES (UOC)	(7) QTY
45	PAHZZ	5305014143012	84760	27660	SETSCREW 6.5 LITER.....	1

END OF FIGURE

## DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE REPAIR PARTS AND SPECIAL TOOLS LIST

ENGINE DIESEL: 8 CYLINDER, NATURALLY ASPIRATED, DETUNED, 6.5 LITER  
ENGINE DIESEL: 8 CYLINDER, NATURALLY ASPIRATED, 6.2 AND 6.5 LITER  
ENGINE DIESEL: 8 CYLINDER, TURBOCHARGED, 6.5 LITER



*Figure 22. Fuel Injection Pump Housing, Head and Rotor, Drive Shaft, and Related Parts.*

(1)	(2)	(3)	(4)	(5)	(6)	(7)
ITEM	SMR			PART	DESCRIPTION AND USABLE ON CODES (UOC)	QTY
NO	CODE	NSN	CAGEC	NUMBER		
GROUP 0302 FUEL PUMP						
FIG. 22 FUEL INJECTION PUMP HOUSING, HEAD AND ROTOR, DRIVE SHAFT, AND RELATED PARTS						
1	PAHZZ	5315011880765	84760	23100	PIN, STRAIGHT, HEADLE.....	1
1	PAHZZ	5315011880766	84760	23685	PIN, STRAIGHT, HEADLE OVERSIZE.....	1
2	PAHZZ	5315011913393	84760	22064	PIN, SHOULDER, HEADED.....	1
3	PAHZZ	5360008871536	84760	10541	SPRING, HELICAL COMP.....	1
4	PAHZZ	3040012470893	84760	29546	SHAFT, SHOULDERED 6.2 LITER, USE WITH PUMP ASSEMBLY P/N DB2829-4523..	1
					UOC: H11, H13, H14, H15, H16, H17, H18, H20, H21, H24, H25, H26, H27, H28, MMM	
4	PAHZZ	3040011883222	84760	24645	SHAFT, DRIVE 6.2 LITER, USE WITH PUMP ASSEMBLY P/N DB2829-4879 AND ALL 6.5 LITER.....	1
5	PAHZZ	5330007571680	84760	10453	PACKING, PREFORMED BLACK PART OF KIT P/N 30405.....	2
6	PAHZZ	5330011925779	84760	21860	PACKING, PREFORMED RED PART OF KIT P/N 30405.....	1
7	PAHZZ	3110011887682	84760	23101	BEARING, ROLLER, NEED.....	1
8	PAHZZ	4820007863971	84760	11563	VALVE, CALIBRATED FL STANDARD.....	1
8	PAHZZ	4820011821073	84760	24441	VALVE, FLOW CONTROL METERING, OVERSIZE.....	1
9	PAHZZ	2910011883255	84760	21895	ARM, METERING VALVE.....	1
10	PAHZZ	5360011893466	84760	21917	SPRING.....	1
11	PAHZZ	4820007863971	84760	11563	VALVE, CALIBRATED FL.....	1
12	PAHZZ	5306008193038	84760	11331	BOLT, MACHINE.....	2
13	PAHZZ	5330012360488	84760	27606	GASKET 6.2 LITER, USE WITH PUMP ASSEMBLY P/N DB2829-4523 PART OF KIT P/N 30405.....	1
					UOC: H11, H13, H14, H15, H16, H17, H18, H20, H21, H24, H25, H26, H27, H28, MMM	
13	PAHZZ	5331006418283	84760	405	O-RING 6.2 LITER, USE WITH PUMP ASSEMBLY P/N DB2829-4879 AND ALL 6.5 LITER PART OF KIT P/N 30405.....	1
14	PAHZZ	5310013181883	84760	23585	NUT, PLAIN, HEXAGON 6.2 LITER, USE WITH PUMP ASSEMBLY P/N DB2829-4879 AND ALL 6.5 LITER.....	1
15	PAHZZ	5307011889217	84760	23352	STUD 6.2 LITER, USE WITH PUMP ASSEMBLY P/N DB2829-4523.....	1
					UOC: H11, H13, H14, H15, H16, H17, H18, H20, H21, H24, H25, H26, H27, H28, MMM	
15	PAHZZ	5307013176317	84760	26495	STUD, BALL 6.2 LITER, USE WITH PUMP ASSEMBLY P/N DB2829-4879 AND ALL 6.5 LITER.....	1
16	PAHZZ	5340014159633	84760	26961	CAP, PROTECTIVE, DUST 6.2 LITER, USE WITH PUMP ASSEMBLY P/N DB2829-4879 AND ALL 6.5 LITER.....	1
17	PAHZZ	5325008042027	96906	MS16624-1093	RING, RETAINING PART OF KIT P/N 30405.....	1
18	PAHZZ	3120003934067	84760	20222	BEARING, WASHER, THRU.....	1

(1) ITEM NO	(2) SMR CODE	(3) NSN	(4) CAGEC	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODES (UOC)	(7) QTY
19	PAHZZ	2910011177252	84760	21312	SLEEVE, GOVERNOR THR.....	1
20	PAHZZ	5325011880958	84760	22937	RING, RETAINING 6.2 LITER, USE WITH PUMP ASSEMBLY P/N DB2829-4523 PART OF KIT P/N 30405.....	1
					UOC: H11, H13, H14, H15, H16, H17, H18, H20, H21, H24, H25, H26, H27, H28, MMM	
20	PAHZZ	5325005981428	84760	10445	RING, RETAINING 6.2 LITER, USE WITH PUMP ASSEMBLY P/N DB2829-4879 AND ALL 6.5 LITER PART OF KIT P/N 30405.	1
21	KAHZZ		84760	27002	HOUSING, INJECTION P 6.2 LITER, USE WITH PUMP ASSEMBLY P/N DB2829-4523..	1
					UOC: H11, H13, H14, H15, H16, H17, H18, H20, H21, H24, H25, H26, H27, H28, MMM	
21	KAHZZ		84760	28861	HOUSING 6.2 LITER, USE WITH PUMP ASSEMBLY P/N DB2829-4879 AND ALL 6.5 LITER.....	1
22	PAHZZ	5315008871539	84760	11141	PIN, STRAIGHT, HEADLE.....	2
23	PAHZZ	3040011893242	84760	24569	SHOE, CAM ROLLER.....	2
24	PAHZZ	5340011598534	84760	11067	PLUNGER, DETENT STANDARD, .290 A, 6.5 LITER.....	2
24	PAHZZ	5340011598535	84760	11068	PLUNGER, DETENT STANDARD, .290 B, 6.5 LITER.....	2
24	PAHZZ	5340011598536	84760	11069	PLUNGER, DETENT STANDARD, .290 C, 6.5 LITER.....	2
24	PAHZZ	3120012395132	75160	11070	BUSHING, SLEEVE STANDARD, .290 D, 6.5. LITER.....	2
24	PAHZZ	5340014159627	84760	11072	PLUNGER, DETENT OVERSIZE, .002 A, 6.5 LITER.....	2
24	PAHZA	5340014334750	84760	11073	PLUNGER, DETENT OVERSIZE, .002 B, 6.5 LITER.....	2
24	PAHZA	5340014334752	84760	11074	PLUNGER, DETENT OVERSIZE, .002 C, 6.5 LITER.....	2
24	PAHZZ	5340014159628	84760	11075	PLUNGER, DETENT OVERSIZE, .002 D, 6.5 LITER.....	2
24	PAHZZ	2910011891748	84760	11057	PLUNGER, ROTOR, FUEL STANDARD, .290 A, 6.2 LITER.....	2
					UOC: AVY, A11, A13, A14, A15, A20, A24, A25, A26, A27, B16, B17, B18, HVY, H11, H13, H14, H15, H16, H17, H18, H20, H21, H24, H25, H26, H27, H28, MMM	
24	PAHZZ	2910011918453	84760	11058	PLUNGER, ROTOR STANDARD, .290 B, 6.2 LITER.....	2
					UOC: AVY, A11, A13, A14, A15, A20, A24, A25, A26, A27, B16, B17, B18, HVY, H11, H13, H14, H15, H16, H17, H18, H20, H21, H24, H25, H26, H27, H28, MMM	
24	PAHZZ	2910011918454	84760	11059	PLUNGER, ROTOR STANDARD, .290 C, 6.2 LITER.....	2
					UOC: AVY, A11, A13, A14, A15, A20, A24, A25, A26, A27, B16, B17, B18, HVY, H11, H13, H14, H15, H16, H17, H18, H20, H21, H24, H25, H26, H27, H28, MMM	
24	PAHZZ	2910011918455	84760	11060	PLUNGER, ROTOR STANDARD, .290 D, 6.2	2

SECTION II			TM9-2815-237-34P	0023 00		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
ITEM NO	SMR CODE	NSN	CAGEC	PART NUMBER	DESCRIPTION AND USABLE ON CODES (UOC)	QTY
24	PAHZZ	2910011918456	84760	11062	LITER..... UOC:AVY,A11,A13,A14,A15,A20,A24,A25, A26,A27,B16,B17,B18,HVY,H11,H13,H14, H15,H16,H17,H18,H20,H21,H24,H25,H26, H27,H28,MMM PLUNGER,ROTOR OVERSIZE,.002 A,6.2	2
24	PAHZZ	2910011918457	84760	11063	LITER..... UOC:AVY,A11,A13,A14,A15,A20,A24,A25, A26,A27,B16,B17,B18,HVY,H11,H13,H14, H15,H16,H17,H18,H20,H21,H24,H25,H26, H27,H28,MMM PLUNGER,ROTOR OVERSIZE,.002 B,6.2	2
24	PAHZZ	2910011918458	84760	11064	LITER..... UOC:AVY,A11,A13,A14,A15,A20,A24,A25, A26,A27,B16,B17,B18,HVY,H11,H13,H14, H15,H16,H17,H18,H20,H21,H24,H25,H26, H27,H28,MMM PLUNGER,ROTOR OVERSIZE,.002 C,6.2	2
24	PAHZZ	2910011918459	84760	11065	LITER..... UOC:AVY,A11,A13,A14,A15,A20,A24,A25, A26,A27,B16,B17,B18,HVY,H11,H13,H14, H15,H16,H17,H18,H20,H21,H24,H25,H26, H27,H28,MMM PLUNGER,ROTOR OVERSIZE,.002 D,6.2	2
25	PFHZZ	2910014145382	84760	31506	HEAD AND ROTOR ASSE 6.5 LITER.....	1
25	PFHZZ	4320013170692	84760	31816	PUMP,ROTARY..... UOC:AVY,A11,A13,A14,A15,A20,A24,A25, A26,A27,B16,B17,B18,HVY,H11,H13,H14, H15,H16,H17,H18,H20,H21,H24,H25,H26, H27,H28,MMM	1
26	PAHZZ	5331012360476	OCTH1	3921937	O-RING PART OF KIT P/N 30405 .....	1
27	PAHZZ	5310012666425	84760	26027	WASHER,FLAT 6.2 LITER,USE WITH PUMP ASSEMBLY P/N DB2829-4523 PART OF KIT P/N 30405..... UOC:H11,H13,H14,H15,H16,H17,H18,H20, H21,H24,H25,H26,H27,H28,MMM	1
28	PAHZZ	5340014140247	84760	29384	PLATE,MOUNTING 6.5 LITER.....	1
28	PAHZZ	2910011883244	84760	21283	PLATE,LOCKING 6.2 LITER..... UOC:AVY,A11,A13,A14,A15,A20,A24,A25, A26,A27,B16,B17,B18,HVY,H11,H13,H14, H15,H16,H17,H18,H20,H21,H24,H25,H26, H27,H28,MMM	1
29	PAHZZ	5305011910374	84760	29710	SCREW,MACHINE.....	1
30	PAHZZ	5305011886567	84760	23124	SCREW.....	1
31	PAHZZ	2910011918464	84760	26070	STOP,VALVE.....	1
32	PAHZZ	5360012605649	84760	26071	SPRING,HELICAL,COMP.....	1
33	PAHZZ	4820011883245	84760	23123	DISK,VALVE STANDARD,6.2 LITER,USE WITH PUMP ASSEMBLY P/N DB2829-4523..	1

(1)	(2)	(3)	(4)	(5)	(6)	(7)
ITEM	SMR			PART	DESCRIPTION AND USABLE ON CODES (UOC)	QTY
NO	CODE	NSN	CAGEC	NUMBER		
33	PAHZZ	4820011883246	84760	23135	UOC:H11,H13,H14,H15,H16,H17,H18,H20, H21,H24,H25,H26,H27,H28,MMM DISK,VALVE OVERSIZE,6.2 LITER,USE WITH PUMP ASSEMBLY P/N DB2829-4523..	1
33	PAHZZ	4820013162497	84760	28012	UOC:H11,H13,H14,H15,H16,H17,H18,H20, H21,H24,H25,H26,H27,H28,MMM VALVE,CHECK STANDARD,6.2 LITER,USE WITH PUMP ASSEMBLY P/N DB2829-4879	1
33	PAHZZ	4820013170552	84760	28013	AND ALL 6.5 LITER..... VALVE,CHECK OVERSIZE,6.2 LITER,USE WITH PUMP ASSEMBLY P/N DB2829-4879 AND ALL 6.5 LITER.....	1
34	PAHZZ	5305002073984	84760	11175	SCREW,CAP, SOCKET HE.....	1
35	PAHZZ	5360011886806	84760	23238	SPRING,FLAT.....	1
36	PAHZZ	5331012360475	84760	27245	O-RING PART OF KIT P/N 30405.....	1
37	PAHZZ	2910011883243	84760	27833	CAM RING,FUEL INJEC STANDARD.....	1
37	PAHZZ	3040011924585	84760	23120	CAM,CONTROL OVERSIZE.....	1
38	PAHZZ	2990013208915	84760	27984	RETAINER ASSEMBLY.....	1
39	PAHZZ	3040011883261	84760	21201	WEIGHT,COUNTERBALAN.....	6
40	PAHZZ	5305011880948	84760	21194	SCREW,MACHINE.....	2
41	PFHZZ	5340011883176	84760	23107	COVER,ACCESS.....	1
42	PAHZZ	5330012332848	0CTH1	3921935	GASKET PART OF KIT P/N 30405.....	1
43	PFHZZ	2910012106938	84760	26890	PILOT TUBE,PUMP.....	1
44	PFHZZ	3120009934152	84760	15093	BUSHING,SLEEVE.....	2
45	PAHZZ	5305011880489	34623	5740572	SCREW ASSY.,VENT GOVERNOR,#0.....	1
45	PAHZZ	5305011880490	84760	21661	SCREW ASSY.,VENT GOVERNOR,#1.....	1
45	PAHZZ	5305011880491	84760	21662	SCREW ASSY.,VENT GOVERNOR,#2.....	1
45	PAHZZ	5305011880492	84760	21663	SCREW ASSY.,VENT GOVERNOR,#3.....	1
45	PAHZZ	5305011880493	84760	21664	SCREW ASSY.,VENT GOVERNOR,#4.....	1
45	PAHZZ	5305011880494	84760	21665	SCREW ASSY.,VENT GOVERNOR,#5.....	1
45	PAHZZ	5305011880491	84760	21662	SCREW ASSY.,VENT GOVERNOR,#1.5.....	1
45	PAHZZ	5305011886566	84760	22734	SCREW GOVERNOR,#2.5.....	1

END OF FIGURE

**BOSCH IN-LINE PUMP**

**M939A2 SERIES 5 TON TRUCK**



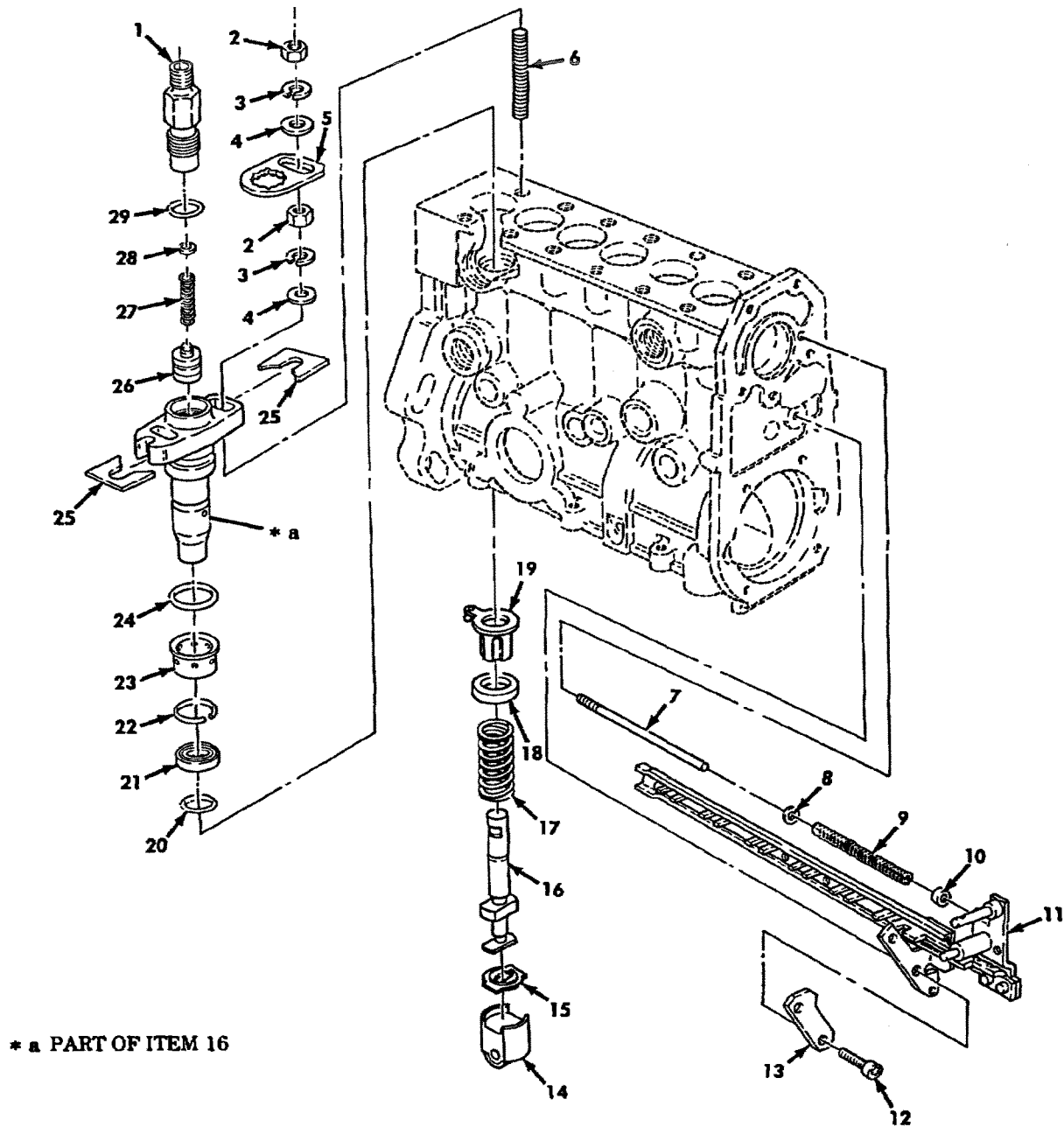


Figure 59. Fuel Injector Pump Plunger and Control Rack (M939A2).

SECTION II					TM 9-2320-272-24P-1	
(1) ITEM NO	(2) SMR CODE	(3) NSN	(4) CAGEC	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODES (UOC)	(7) QTY
GROUP 0302 FUEL PUMPS						
FIG. 59 FUEL INJECTOR PUMP PLUNGER AND CONTROL RACK(M939A2)						
1	PFHZZ	4820013004257	53867	1 413 356 040	RETAINER,DISK,VALVE ..... UOC: ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	6
2	PFHZZ	5310013368721	5T151	1 413 300 023	NUT,PLAIN,HEXAGON PART OF KIT P/N ..... 57K0144 ..... UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	12
3	PFHZZ	5310013368865	5T151	1 410 151 002	WASHER,LOCK PART OF KIT P/N 57K0144 ..... UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	12
4	PFHZZ	5365013031612	3867	1 410 200 019	SPACER,RING PART OF KIT P/N 57K0144 ..... UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	12
5	PFHZZ	5310013011802	53867	1 410 149 001	WASHER,KEY ..... UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	6
6	PFHZZ	5307013017815	53867	1 413 500 006	STUD,PLAIN ..... UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	6
7	PFHZZ	5315013359941	53867	1 413 105 008	PIN,GROOVED,HEADLES ..... UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	1
8	PFHZZ	5310013366748	5T151	2 916 020 010	WASHER,FLAT ..... UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	1
9	PFHZZ	5360013359947	5T151	1 424 610 053	SPRING,HELICAL,COMP ..... UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	1
10	PFHZZ	5340013390839	5T151	1 420 505 062	SEAT,HELICAL COMPRE ..... UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	1
11	PFHZZ	5340013363889	5T151	1 416 016 013	BRACKET,LEVER ..... UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	1
12	PAHZZ	5305013017817	53867	2 914 552 158	SCREW,CAP,HEXAGON H ..... UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	2
13	XBHZZ		5T1511	411 032 004	STOP PLATE ..... UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	1
14	PFHZZ	2910013019936	53867	1418-710-019	TAPPET,ROLLER,FUEL ..... UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	6
15	PFHZZ	5340013007154	53867	1 410 520 007	SEAT,HELICAL COMPRE ..... UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	6
16	PFHZZ	910013382335	5T151	1 418 415 082	PLUNGER ASSEMBLY,FU ..... UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	6

## SECTION II

(1) ITEM NO	(2) SMR CODE	(3) NSN	(4) CAGEC	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODES (UOC)	(7) QTY
					UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
17	PFHZZ	5360013006888	53867	1 414 618 030	SPRING,HELICAL,COMP ..... UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	6
18	PFHZZ	5340013007153	53867	1 410 505 015	SEAT,HELICAL COMPRE ..... UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	6
19	PFHZZ	2910013004271	53867	1 410 422 031	SLEEVE,GOVERNOR,FUE ..... UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	6
20	PFHZZ	5331013015992	53867	1410210503	O-RING 16 X 3MM PART OF KIT P/N 1 ..... 417 010 008..... UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	6
21	PFHZZ	5365013007149	53867	1 410 290 005	SPACER,RING PART OF KIT P/N 1 417 ..... 010 008 ..... UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH,- ZAJ,ZAK,ZAL	6
22	KFHZ		5T151	1 414 601 004	RETAINER RING PART OF KIT P/N 1 417 ..... 010 008 ..... UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	6
23	PFHZZ	5365013007021	3867	1 410 505 023	SPACER,SLEEVE ..... UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	6
24	PFHZZ	5331013017867	53867	1 410 210 501	O-RING 19 X 2MM PART OF KIT P/N 1 ..... 417 010 008..... UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL K)	6
25	PFHZZ	5365013007158	53867	1 411 030 134	SPACER,PLATE 1.00 MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013007159	53867	1 411 030 135	SPACER,PLATE 1.05MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013007160	53867	1 411 030 136	SPACER,PLATE 1.10MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013010554	53867	1 411 030 137	SPACER,PLATE 1.15MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013007161	53867	1 411 030 138	SPACER,PLATE 1.20MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013007162	53867	1 411 030 139	SPACER,PLATE 1.25MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013007163	53867	1 411 030 140	SPACER,PLATE 1.30MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013007164	53867	1 411 030 141	SPACER,PLATE 1.35MM THICK ..... V	

SECTION II						
(1)	(2)	(3)	(4)	(5)	(6)	(7)
ITEM	SMR	NSN	CAGEC	PART	DESCRIPTION AND USABLE ON CODES (UOC)	QTY
NO	CODE			NUMBER		
25	PFHZZ	5365013007165	53867	1 411 030 142	UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL SPACER,PLATE 1.40MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013007166	53867	1 411 030 143	SPACER,PLATE 1.45MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013007167	53867	1 411 030 144	SPACER,PLATE 1.50MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013007168	53867	1 411 030 145	SPACER,PLATE 1.55MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013007169	53867	1 411 030 146	SPACER,PLATE 1.60MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013030937	58367	1 411 030 147	SPACER,PLATE 1.65MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013049530	53867	1 411 030 148	SPACER,PLATE 1.70MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013029953	53867	1 411 030 149	SPACER,PLATE 1.75MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013030938	53867	1 411 030 150	SPACER,PLATE 1.80MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013041802	53867	1 411 030 151	SPACER,PLATE 1.85MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013007170	53867	1 411 030 152	SPACER,PLATE 1.90MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013007171	53867	1 411 030 153	SPACER,PLATE 1.95MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013007172	53867	1 411 030 154	SPACER,PLATE 2.00MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013007173	53867	1 411 030 155	SPACER,PLATE 2.05MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013007174	53867	1 411 030 156	SPACER,PLATE 2.10MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013007175	53867	1 411 030 157	SPACER,PLATE 2.15MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013007176	53867	1 411 030 158	SPACER,PLATE 2.20MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH,	

SECTION II						
(1)	(2)	(3)	(4)	(5)	(6)	(7)
ITEM	SMR			PART	DESCRIPTION AND USABLE ON CODES (UOC)	QTY
NO	CODE	NSN	CAGEC	NUMBER		
25	PFHZZ	5365013007177	53867	1 411 030 159	ZAJ,ZAK,ZAL SPACER,PLATE 2.25MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013007178	53867	1 411 030 160	SPACER,PLATE 2.30MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013007179	53867	1 411 030 161	SPACER,PLATE 2.35MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013007180	53867	1 411 030 162	SPACER,PLATE 2.40MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013007181	53867	1 411 030 163	SPACER,PLATE 2.45MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013007182	53867	1 411 030 164	SPACER,PLATE 2.50MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013025848	53867	1 411 030 165	SPACER,PLATE 2.55MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAD,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013007183	53867	1 411 030 166	SPACER,PLATE 2.60MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013007184	53867	1 411 030 167	SPACER,PLATE 2.65MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013007185	53867	1 411 030 168	SPACER,PLATE 2.70MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013007186	53867	1 411 030 169	SPACER,PLATE 2.75MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013007187	53867	1 411 030 170	SPACER,PLATE 2.80MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013014006	53867	1 411 030 171	SPACER,PLATE 2.85MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013014007	53867	1 411 030 173	SPACER,PLATE 2.95MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
25	PFHZZ	5365013007188	53867	1 411 030 172	SPACER,PLATE 3.00MM THICK ..... V UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	
26	PFHZZ	2910013398598	5T151	1 418 512 225	VALVE,FUEL SYSTEM ..... UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	6
27	PFHZZ	5360013006889	53867	1 414 613 002	SPRING,HELICAL,COMP PART OF KIT P/N ..... 57K0144 ..... UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH,	6

SECTION II

(1) ITEM NO	(2) SMR CODE	(3) NSN	(4) CAGEC	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODES (UOC)	(7) QTY
28	PFHZZ	5310013017807	53867	1 410 100 002	ZAJ,ZAK,ZAL WASHER,FLAT PART OF KIT P/N 57K0144..... UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ, ZAK, ZAL	6
29	PFHZZ	5331013031635	53867	1 410 210 041	O-RING 13 X 2.5MM PART OF KIT P/N 1..... 417 010 008..... UOC:ZAA,ZAB,ZAC,ZAD,ZAE,ZAF,ZAG,ZAH, ZAJ,ZAK,ZAL	6

END OF FIGURE

**DETROIT DIESEL UNIT INJECTOR**

**M977 10 TON SERIES TRUCK HEMTT**

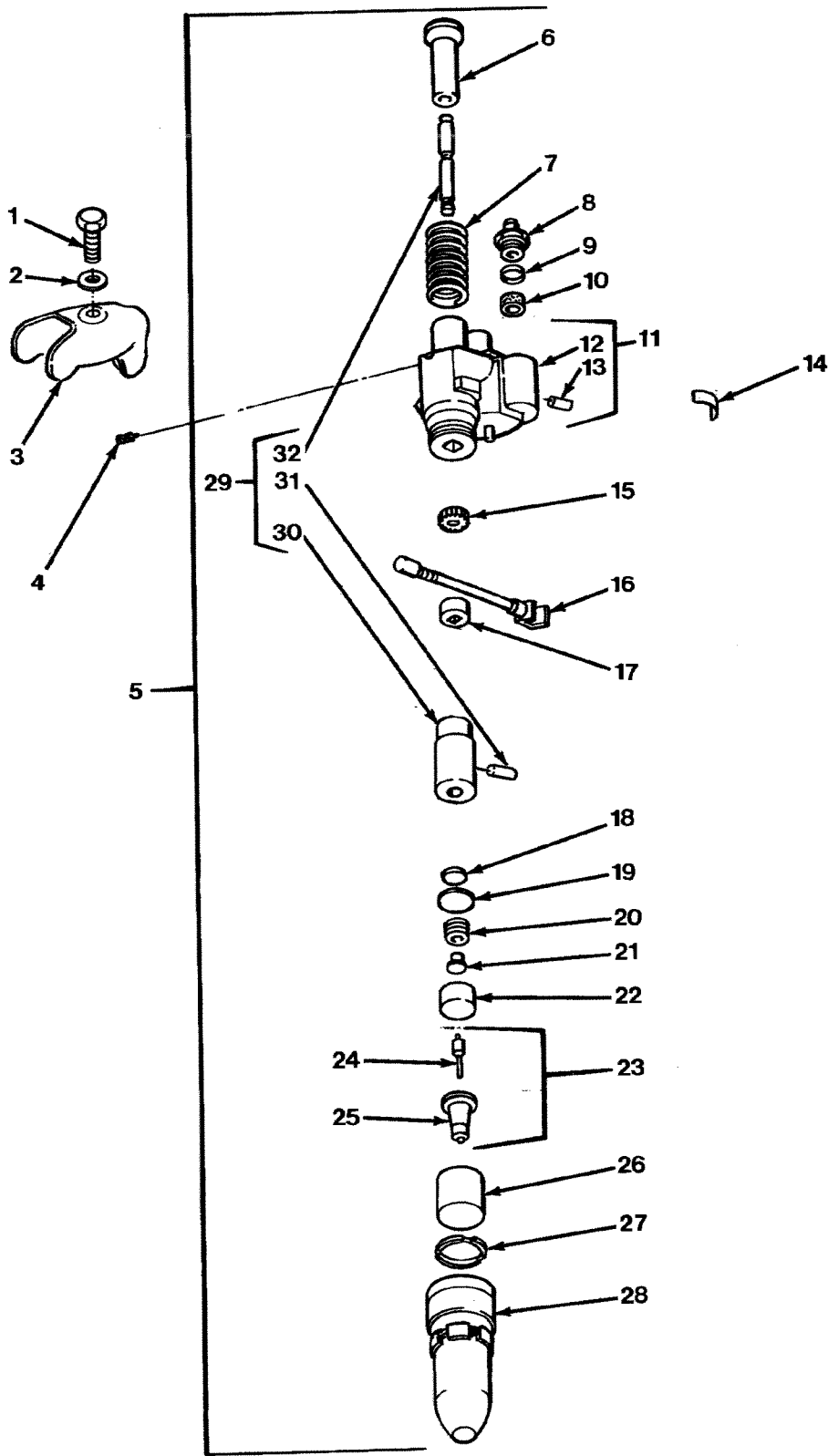


FIG.29 FUEL INJECTOR



SECTION II				TM 9-2320-279-24P, C04	
(1)	(2)	(3)	(4)	(5)	(6)
ITEM	SMR		PART		
NO	CODE	CAGEC	NUMBER	DESCRIPTION AND USABLE ON CODES(UOC)	QTY
GROUP 03 FUEL SYSTEM					
GROUP 0301 CARBURETOR, FUEL INJECTOR					
FIG.29 FUEL INJECTOR					
1	PAFZZ	80204	B1821BH038C200N	SCREW,CAP,HEXAGON H .....	8
2	PAFZZ	72582	5161621	WASHER,CONVEX .....	8
3	PAFZZ	72582	5121259	CLAMP,FUEL INJECTOR USED ON ENGINE ..	8
				A/N 8087-7899	
4	PADZZ	72582	5228608	PIN,STOP,FUEL INJEC .....	1
5	PAFDH	72582	5229630	NOZZLE,FUEL INJECTI USED ON ENGINE ...	8
				A/N 8087-7899	
5	PAFDH	72582	5226410	INJECTOR ASSY,FUEL USED ON ENGINE .....	8
				A/N 8083-7493	
6	PADZZ	72582	05228104	.PIN,GROOVED,HEADED .....	1
7	PADZZ	72582	5228739	.SPRING,HELICAL,COMP .....	1
* 8	KFDZZ	72582	5228588	.ADAPTER,STRAIGHT,TU .....	2
9	PAHZZ	75078	00-017054	.GASKET,FUEL USED ON ENGINE A/N .....	2
				8087-7899	
9	KFDZZ	79150	19108	.SPACER,RING PART OF KIT P/N .....	2
				5226576	
10	PAHZZ	75078	00-017066	.FILTER,INJECTOR USED ON ENGINE A/N ..	1
				8087-7899	
10	KFHZZ	72582	5229778	.FILTER ELEMENT,FLUI PART OF KIT .....	1
				P/N 5226576 USED ON ENGINE A/N	
				8083-7493	
11	PFDZZ	72582	5228583	.HOLDER,FUEL INJECTO .....	1
12	XADZZ	72582	5228583-1	..BODY .....	1
13	PADZZ	72582	5226416	..PIN,STRAIGHT,HEADLE .....	1
14	PFDZZ	72582	5229624	.IDENTIFICATION PLAT .....	1
15	PADZZ	72582	5228802	.GEAR,SPUR .....	1
16	PADZZ	72582	5226719	.RACK,INJECTOR .....	1
17	PADZZ	72582	5228586	.SPACER,SLEEVE .....	1
18	PADZZ	81381	5228694	.DISK,SOLID,PLAIN .....	1
19	PADZZ	71934	5228696	.GAGE,VALVE INJECTOR .....	1
20	KFDZZ	72582	5228596	.SPRING,HELICAL,COMP PART OF KIT .....	1
				P/N 5228769	
21	KFDZZ	72582	5228766	.SEAT,HELICAL COMPRE PART OF KIT .....	1
				P/N 5228769	
22	PADZZ	72582	5228594	.SEAT,HELICAL COMPRE .....	1
23	PADZZ	72582	5229622	.SPRAY TIP,NOZZLE,FU USED ON ENGINE ..	1
				A/N 8087-7899	
23	PADZZ	72582	5226438	.SPRAY TIP,NOZZLE,NO USED ON ENGINE ..	1
				A/N 8083-7493	
24	XADZZ	72582	5226438-1	..PIN USED ON ENGINE A/N 8083-7493 ...	1
24	XADZZ	72582	5229622-1	..PIN USED ON ENGINE A/N 8087-7899 ...	1
25	XADZZ	72582	5226438-2	..TIP USED ON ENGINE A/N 8083-7493 ...	1
25	XADZZ	72582	5229622-2	..TIP USED ON ENGINE A/N 8087-7899 ...	1
26	PADZZ	72582	5228109	.DEFLECTOR,INJECTOR .....	1
27	KFDZZ	72582	5234281	.PACKING,PREFORMED PART OF KIT P/N ...	1
				5226576	

SECTION II				TM 9-2320-279-24P	(5)	(6)
(1)	(2)	(3)	(4)			
ITEM	SMR		PART			
NO	CODE	CAGEC	NUMBER	DESCRIPTION AND USABLE ON CODES(UOC)		QTY
28	PADZZ	72582	5228601	.NUT,INJECTOR,VALVE .....		1
29	PAHZZ	72582	5229292	.PLUNGER AND BUSHING USED ON ENGINE ..		1
				A/N 8087-7899		
29	PAHZZ	72582	5226338	.PLUNGER AND BUSHING USED ON ENGINE ..		1
				A/N 8083-7493		
30	XADZZ	72582	5229292-1	..BUSHING USED ON ENGINE A/N .....		1
				8087-7899		
30	XAHZZ	72582	5226338-1	..BUSHING USED ON ENGINE A/N .....		1
				8083-7493		
31	PFDZZ	72582	5226393	..PIN,STRAIGHT,HEADLE .....		1
32	XADZZ	72582	5229292-2	..PLUNGER USED ON ENGINE A/N .....		1
				8087-7899		
32	XAHZZ	72582	5226338-2	..PLUNGER USED ON ENGINE A/N .....		1
				8083-7493		

END OF FIGURE

**CATERPILLAR UNIT INJECTOR**

**COMBAT EARTHMOVER (DEUCE)**

**TM 5-2430-200-24P**

# Parts Manual

---

## **Deployable Universal Combat Earthmover (DEUCE)**

---

**30/30 (Model DV100)**

**NSN: 2430-01-423-2819**

**PIN: 7RR00003-Up (Machine)**

**4CW00222-Up (Engine)**

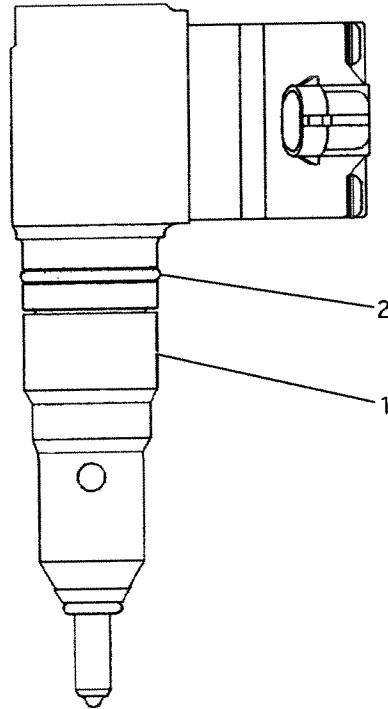
**Approved for public release; distribution is unlimited.**

**Headquarters, Department of the Army**

**March 1, 2001**

*Entered in database*

# FUEL SYSTEM



NOTE	REF NO	PART NUMBER	QTY	PART NAME	NOTE	REF NO	PART NUMBER	QTY	PART NAME
	1	1167150	1	INJECTOR GP					
	2	1148718	1	SEAL-FUEL SYSTEM					

**1197001 PUMP GP-FUEL INJECTOR**  
Part of 1420725 Engine Ar-Core

**CUMMINS PT PUMP**

**ROUGH TERRAIN CONTAINER HANDLER**

# **TM 10-3930-675-24P**

---

**ORGANIZATIONAL, DIRECT SUPPORT, AND GENERAL SUPPORT  
MAINTENANCE REPAIR PARTS AND SPECIAL TOOLS LISTS (RPSTL)  
(INCLUDING DEPOT MAINTENANCE REPAIR PARTS)**

**FOR**

**ROUGH TERRAIN CONTAINER HANDLER (RTCH):  
RT 240; 53,000 LB CAPACITY; 4 X 4  
(NSN 3930-01-473-3998)**

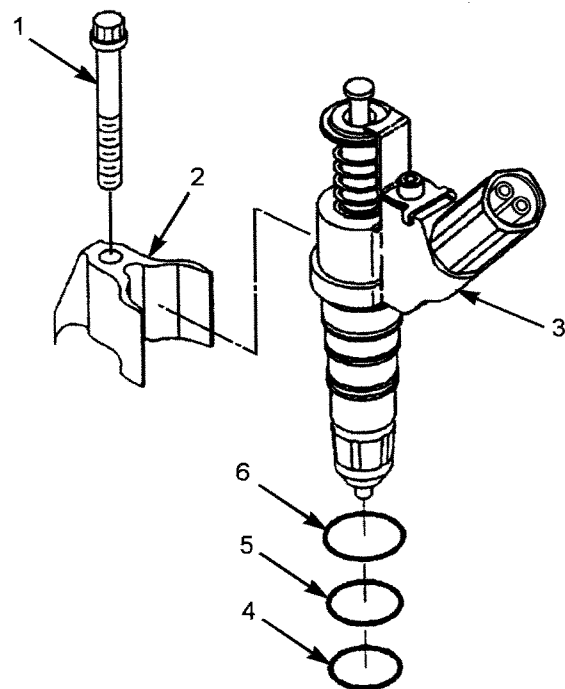


Approved for public release; distribution is unlimited.

---

**HEADQUARTERS, DEPARTMENT OF THE ARMY**

**JULY 2001**



374-0027

Figure 30. Fuel Injector

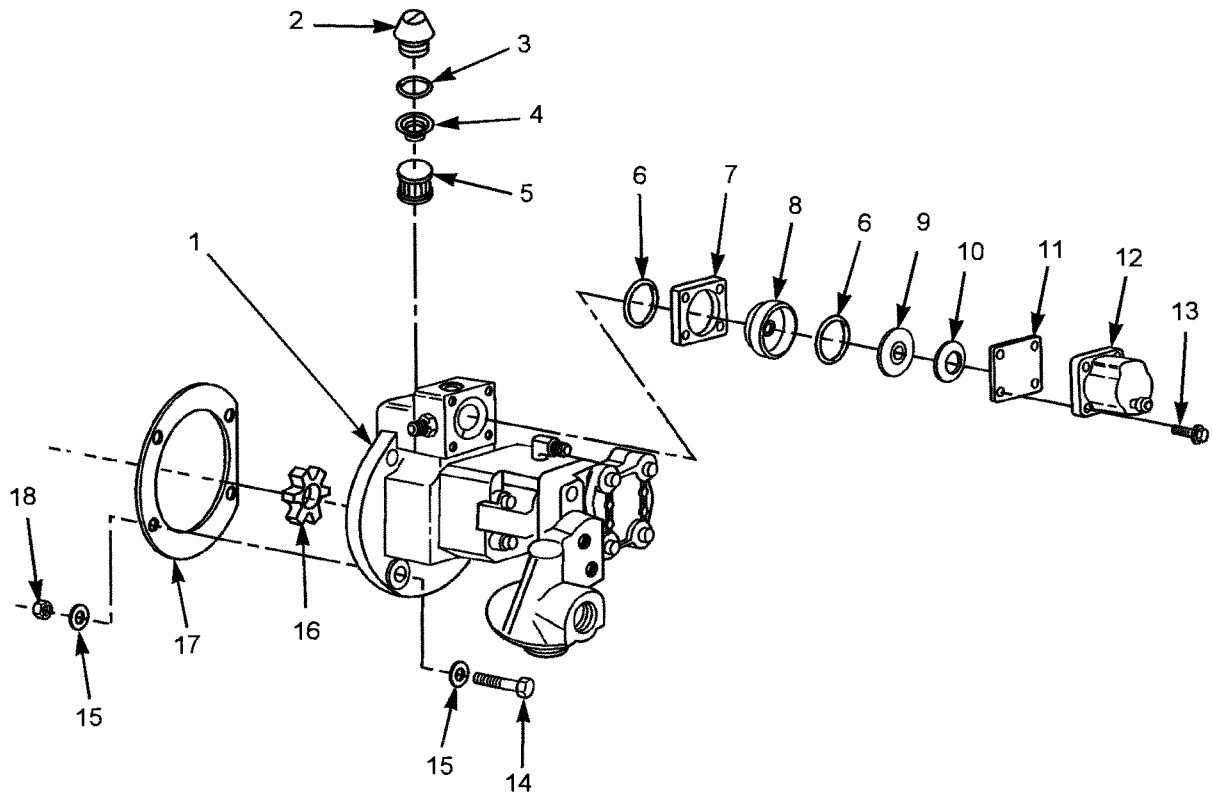


## SECTION II

TM 10-3930-675-24P

(1) ITEM NO	(2) SMR CODE	(3) NSN	(4) CAGEC	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODES (UOC)	(7) QTY
					GROUP 03 FUEL SYSTEM	
					GROUP 0301 CARBURETOR, FUEL INJECTOR	
					FIG. 30 FUEL INJECTOR	
1	PAFZZ		15434	3882793	SCREW, TWELVE POINT CAP . . . . . M 10 X 1.25 X 75	6
2	PAFZZ		15434	4022914	CLAMP, INJECTOR . . . . .	6
3	PAFZZ		15434	4026222	INJECTOR . . . . .	6
4	PAFZZ	5331-01-425-8570	15434	3070138	O-RING . . . . .	1
5	PAFZZ	5331-01-425-8569	15434	3070137	O-RING . . . . .	1
6	PAFZZ	5331-01-425-8568	15434	3070136	O-RING . . . . .	1
					END OF FIGURE	

1  
2 - 13



374-0051

Figure 31. Fuel Pump

## SECTION II

TM 10-3930-675-24P

(1) ITEM NO	(2) SMR CODE	(3) NSN	(4) CAGEC	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODES (UOC)	(7) QTY
GROUP 0302 FUEL PUMPS						
FIG. 31 FUEL PUMP						
1	PAFFF	2910-01-484-6145	15434	3090942	PUMP, FUEL, METERING .....	1
2	PAOZZ	5365-01-484-6134	15434	3014575	.CAP, FUEL PUMP FILTER .....	1
3	PAOZZ	5330-01-237-4961	15434	3021123	.GASKET .....	1
4	PAOZZ	5360-00-597-4570	15434	70700	.SPRING, HELICAL, COMP .....	1
5	PAOZZ	2910-00-790-8736	15434	14648300	.FILTER ELEMENT, FLUID .....	1
6	PAOZZ	5331-00-081-9299	15434	129888	.O-RING .....	2
7	PAOZZ	3010-01-484-6147	15434	3034451	.HOUSING, ACTUATOR .....	1
8	PAOZZ	4820-01-312-4486	15434	3056009	.DISK, VALVE .....	1
9	PAOZZ	4820-01-287-9742	15434	196057	.DISK, VALVE .....	1
10	PAOZZ	5310-00-082-1888	15434	129768	.WASHER, SPRING TENS I .....	1
11	PAOZZ	5340-00-084-7787	15434	129839	.COVER, ACCESS .....	1
12	PAOZZ	5945-01-426-4007	15434	3054608	.SOLENOID, ELECTRICAL .....	1
13	PAOZZ	5305-01-325-5969	15434	3065944	.SCREW ASSEMBLY, PANEL .....	4
14	PAFZZ	5306-01-484-3524	15434	3064109	SCREW, CAP, HEXAGON H .....	4
15	PAFZZ	5310-01-481-2498	15434	3009330	WASHER, FLAT .....	8
16	PAFZZ	3010-00-507-8347	15434	3046200	INSERT, FLEXIBLE COUP .....	1
17	PAFZZ	5330-01-338-4829	15434	3069103	GASKET .....	1
18	PAFZZ	5310-01-381-1161	15434	3044360	NUT, PLAIN, HEXAGON .....	4
END OF FIGURE						

**CATERPILLAR CAM ACTUATED PUMP**

**100KW GENERATOR**

AIR FORCE  
ARMY  
NAVY PUBLICATION  
MARINE CORPS

TO 35C2-3-442-14  
TM5-6115-600-24P  
NAVFAC P-3-628-24P  
SL-4-07464B

---

**TECHNICAL MANUAL**

**ORGANIZATIONAL, INTERMEDIATE  
(FIELD)(DIRECT AND GENERAL SUPPORT)  
AND DEPOT MAINTENANCE  
REPAIR PARTS AND SPECIAL TOOLS LIST**

**GENERATOR SET, DIESEL ENGINE  
DRIVEN, TACTICAL SKID MTD.  
100 KW, 3 PHASE, 4 WIRE,  
120/208 AND 240/416 VOLTS**

BASIC AND ALL CHANGES HAVE BEEN MERGED TO MAKE THIS A COMPLETE PUBLICATION

DOD MODEL  
MEP007B

CLASS  
PRECISE

HERTZ  
50/60

NSN  
6115-01-036-6374

INCLUDING OPTIONAL KITS

DOD MODEL  
MEP007BWF  
MEP007BWE  
MEP116AQM

NOMENCLATURE  
WINTERIZATION KIT, FUEL BURNING  
WINTERIZATION KIT, ELECTRIC  
WHEEL MOUNTING KIT

NSN  
6115-01-131-7228  
6115-01-135-6165  
6115-01-135-6165

DISTRIBUTION STATEMENT A - Approved for public release; distribution is unlimited.

---

Published Under the Authority of the Secretary of the Air Force, Army, Navy, and Marine Corps

**4 MAY 1992**

**CHANGE 4 - 21 DECEMBER 2001**

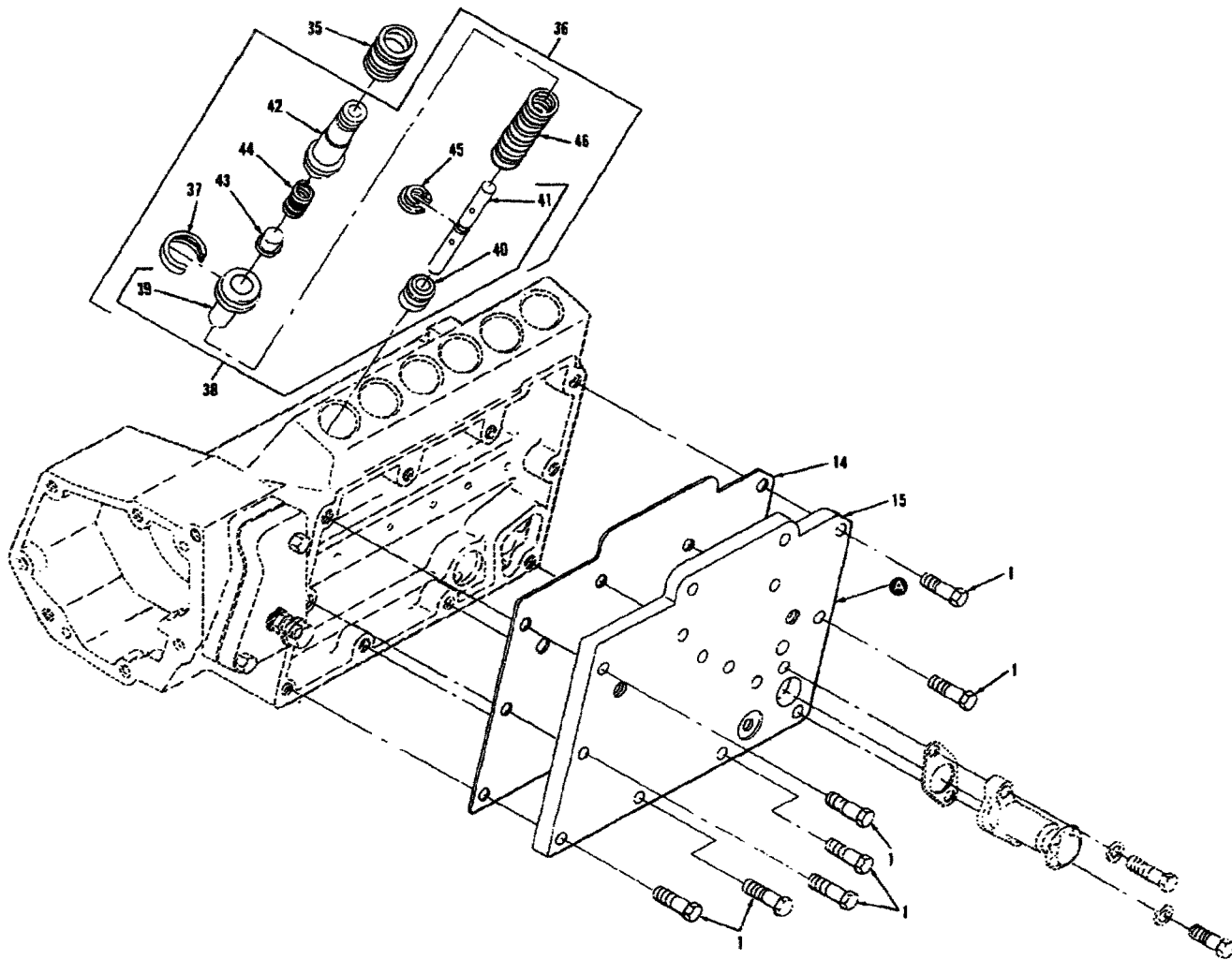


Figure 40. Fuel Injection Pump (Sheet 1 of 4)

SECTION II. REPAIR PARTS FOR ORGANIZATIONAL, INTERMEDIATE (FIELD)  
 (DIRECT AND GENERAL SUPPORT) AND DEPOT MAINTENANCE

(1) ILLUS- TRATION		(2) SMR CODE				(3) USMC		(4)	(5) DESCRIPTION USABLE ON		(6)	(7) QTY INC IN UNIT	(8) USMC QTY PER EQUIP
a	b	a	b	c	d	a	b	NATIONAL STOCK NUMBER	REF NUMBER & MFR CODE	CODE	UM		
FIG NO.	ITEM NO.	ARMY	AIR FORCE	NAVY	USMC	SSI	REPL FACTOR						
									GROUP 05 FUEL SYSTEM				
40		PAFHH	PAFFF	PAHZZ	PAHHH		.013	2910-01-125-4319	FUEL INJECTION PUMP SR3842	11083	EA	1	1
40	1	PAZZZ	PAFZZ	PAZZZ	PAHZZ	D	.008	5306-00-261-4453	BOLT, HEX 51615	11083	EA	13	28
40	2	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.008	5306-00-721-5679	BOLT, HEX 9P6380	11083	EA	4	4
40	3	PAHZZ	PAFZZ	PAHZZ	PAHZZ		.030	5330-01-068-7345	GASKET, P O KIT P/N 6N1133 6N2843	11085	EA	1	1
40	4	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.006	4731-00-069-1411	ELBOW 4N7572	11083	EA	1	1
40	4A	PAFZZ	PAFZZ	PAHZZ	PAHZZ		.030	4820-01-053-4586	ELBOW, CHECK VALVE HN1828	11083	EA	1	1
40	5	PAHZZ	PAFZZ	PAHZZ	PAHZZ		.030	5330-01-068-7344	GASKET, P O KIT P/N 6N1133 4N9337	11083	EA	1	1
40	6	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.008	2910-01-068-9785	DISC 4N9336	11083	EA	1	1
40	7	XB	XB	XB	XB				HOUSING 1P1420	11085	EA	1	1
40	8	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.005	4820-01-103-3732	VALVE ASSY 7N450	11083	EA	1	1
40	9	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.008	4730-01-106-4024	PLUG 4N5050	11083	EA	1	1
40	10	PAHZZ	PAFZZ	PAHZZ	PAHZZ			2910-01-068-6095	CHANNEL 6N2810	11085	EA	1	1
40	11	PAHZZ	PAFZZ	PAHZZ	PAHZZ		.030	5330-01-069-0985	GASKET, P O KIT P/N 6N1133 4N4431	11083	EA	1	1
40	12	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.008	2520-01-067-2179	PLUG 954180	11083	EA	1	1
40	13	PAHZZ	PAFZZ	PAHZZ	PAHZZ		.030	5365-00-194-4472	PACKING, P O KIT P/N 6N1133 47533	11083	EA	1	1
40	14	PAHZZ	PAFZZ	PAHZZ	PAHZZ		.030	5330-01-127-8567	GASKET, P O KIT P/N 6N1133 4N9057	11083	EA	1	1
40	15	PAHZZ	PAFZZ	PAHZZ	PAHZZ			2910-01-128-9190	COVER 4N4351	11083	EA	1	1
40	16	APF	APF	AHHZZ	AHHZZ				PUMP, FUEL INJECTION 6N205	11083	EA	1	1
40	17	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.008	5305-00-004-7245	BOLT, HEX 2M5471	11083	EA	2	2
40	18	PAFZZ	PAFZZ	PAFZZ	PAFZZ			2910-01-140-8212	COVER ASSY 4N1591	11083	EA	1	1
40	19	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.008	5306-01-024-7524	BOLT, HEX 2P3200	11083	EA	1	1
40	20	PAHZZ	PAFZZ	PAHZZ	PAHZZ		.030	5330-00-613-6500	SEAL P O KIT P/N 6N1133 1J1671	11083	EA	1	2
40	21	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.008	5305-01-025-4359	SCREW ASSY 6N412	11083	EA	1	1
40	22	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.008	5310-00-138-0238	NUT 4B2042	11083	EA	1	1
40	23	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.010	5310-00-045-3299	WASHER, LOCK MS362338-42	11083	EA	1	1
40	24	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.010	5310-00-450-0414	WASHER, FLAT 8P1326	11083	EA	1	1

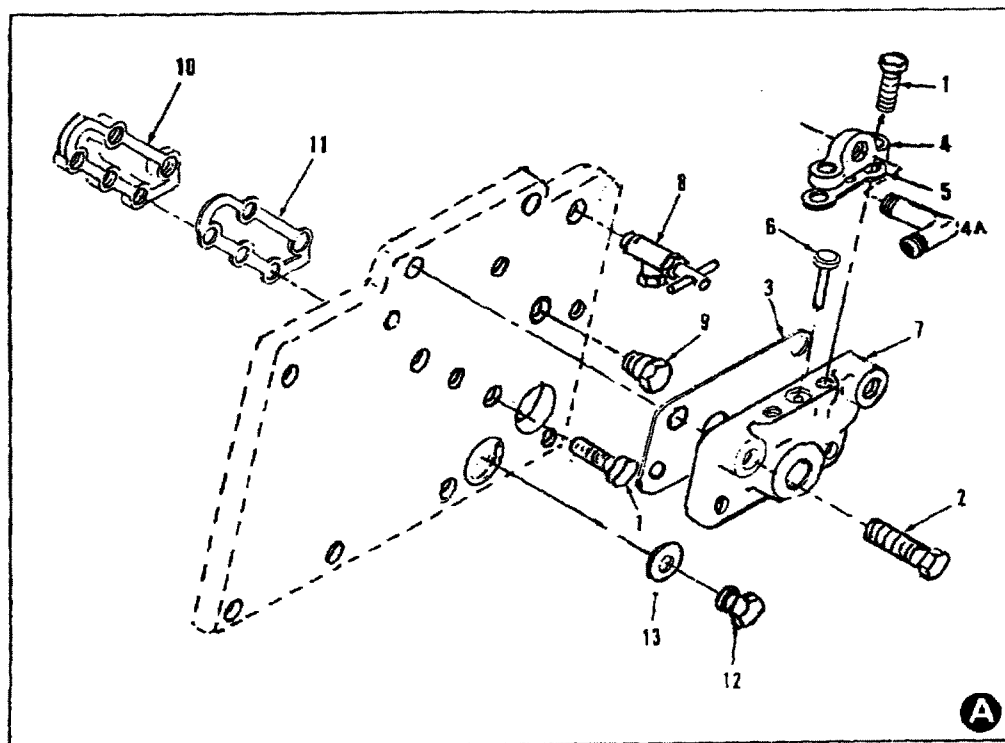


Figure 40. Fuel Injection Pump (Sheet 2 of 4)



AIR FORCE  
ARMY  
NAVY  
MARINE CORPS

T.O. 35C2-3-442-14  
TM5-6115-600-24P  
NAVFAC P-8-628-24P  
SL-4-07464B

SECTION II. REPAIR PARTS FOR ORGANIZATIONAL, INTERMEDIATE (FIELD)  
(DIRECT AND GENERAL SUPPORT) AND DEPOT MAINTENANCE

(1) ILLUS- TRATION		(2) SMR CODE				(3) USMC		(4) NATIONAL STOCK NUMBER	(5) DESCRIPTION USABLE ON CODE		(6) U/M	(7) QTY INC IN UNIT	(8) USMC QTY PER EQUIP
a	b	a	b	c	d	a	b		REF NUMBER & MFR CODE	ON CODE			
FIG NO.	ITEM NO.	ARMY	AIR FORCE	NAVY	USMC	SSI	REPL FACTOR						
									GROUP 05 - FUEL SYSTEM - CONTINUED				
									FUEL INJECTION PUMP - CONTINUED				
40													
40	25	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.010	5310-01-023-9105	WASHER, FLAT 1P7526	11083	EA	1	1
40	26	XBHZZ	PAFZZ	PAHZZ	PAHZZ	D	.003	2910-01-104-9318	COVER 6N411	11083	EA	1	1
40	27	PAHZZ	PAFZZ	PAHZZ	PAHZZ		.030	5330-01-024-3368	GASKET, P/O KIT P/N 6N1133 4N308	11083	EA	1	1
40	28	PAHZZ	PAFZZ	PAHZZ	PAHZZ		.030	5330-00-252-0577	PACKING, P/O KIT P/N 6N1133 MS28775-007	96906	EA	1	1
40	29	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.005	2530-01-068-9709	SHAFT 4N328	11083	EA	1	1
40	30	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.015	5360-01-023-9435	PRING 4N605	11083	EA	1	1
40	31	PAZZZ	PAFZZ	PAHZZ	PAHZZ	D	.005	2910-01-024-1512	VALVE 4N1767	11083	EA	1	1
40	32	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.008	5305-01-024-4794	SCREW, PAN HEAD 2N2658	11083	EA	1	7
40	33	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.003	4310-01-068-9779	LEVER 4N1763	11083	EA	1	6
40	34	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.005	2910-01-125-4534	SHAFT ASSY 4N0572	11083	EA	1	1
40	35	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.008	3120-01-022-3955	BUSHING 4N218	11083	EA	6	6
40	36	APF	APF	AHH	AHH			2910-01-024-0963	PUMP ASSY 4N3898	11083	EA	6	6
40	37	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.013	5365-01-024-5118	RING 4N224	11083	EA	1	6
40	38	PAHZZ	PAFZZ	PAHZZ	PAHZZ		.013	2910-01-024-0939	PUMP, FUEL INJECTION 6N7527	11083	EA	1	6
40	39	XA	XA	XA	XA				BARREL 4N2034	11083	EA	1	6
40	40	XA	XA	XA	XA				SLEEVE 4N1764	11083	EA	1	6
40	41	XA	XA	XA	XA				PLUNGER 4N1762	11083	EA	1	6
40	42	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.008	2910-01-024-1513	BONNET 4N209	11083	EA	1	6
40	43	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.005	2910-00-923-2466	VALVE 9B1320	11083	EA	1	6
40	44	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.015	5360-01-024-2608	SPRING 9L9424	11083	EA	1	6
40	45	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.013	5310-01-062-0380	WASHER 4N2728	11083	EA	1	6
40	46	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.015	5360-01-105-9599	SPRING 9N5862	11083	EA	1	6
40	47	PAHZZ	PAFZZ	PAHZZ	PAHZZ		.030	5330-00-310-6375	SEAL, P/O KIT P/N 1133 6P6672	11083	EA	6	6
40	48	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.008	2910-01-125-4520	LIFTER 8N1317	11083	EA	6	6
40	49	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.009	2910-01-024-2868	ROLLER 4N2583	11083	EA	6	6

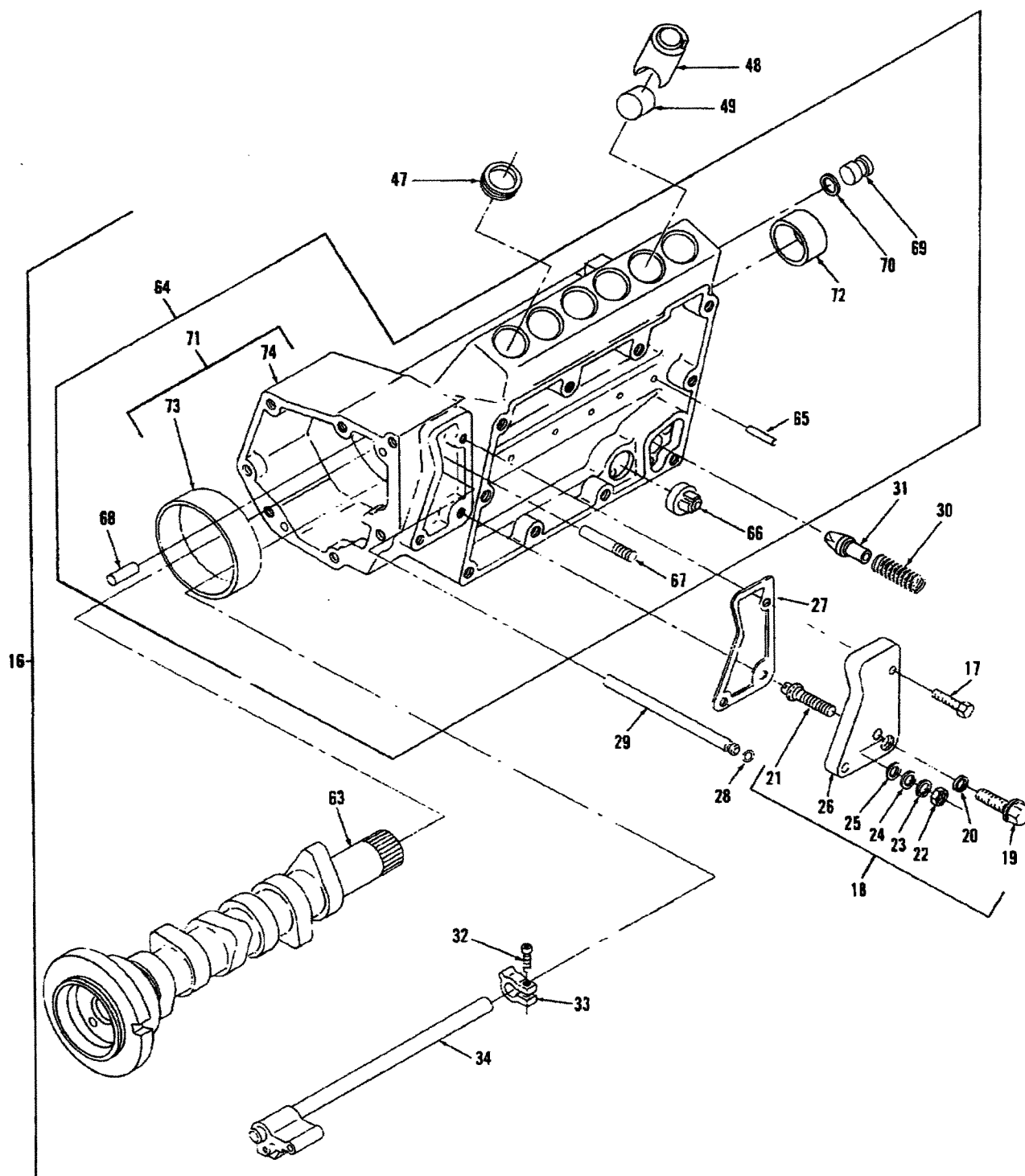


Figure 40. Fuel Injection Pump (Sheet 3 of 4)

AIR FORCE  
ARMY  
NAVY  
MARINE CORPS

T.O. 35C2-3-442-14  
TMS-6115-600-24P  
NAVFAC P-8-628-24P  
SL-4-07464B

SECTION II. REPAIR PARTS FOR ORGANIZATIONAL, INTERMEDIATE (FIELD)  
(DIRECT AND GENERAL SUPPORT) AND DEPOT MAINTENANCE

(1) ILLUS- TRATION		(2) SMR CODE				(3) USMC		(4)	(5) DESCRIPTION USABLE ON		(6)	(7) QTY INC IN UNIT	(8) USMC QTY PER EQUIP
a	b	a	b	c	d	a	b	NATIONAL STOCK NUMBER	REF NUMBER & MFR CODE	CODE	U/M		
FIG NO.	ITEM NO.	ARMY	AIR FORCE	NAVY	USMC	SSI	REPL FACTOR						
									GROUP 05 - FUEL SYSTEM - CONTINUED				
									FUEL INJECTION PUMP - CONTINUED				
40													
40	50	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.006	4730-01-023-8633	FITTING 1P4001	11083	EA	1	2
40	51	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.008	4730-01-068-7124	SLEEVE, CAMSHAFT 4N2954	11083	EA	1	1
40	52	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.008	5306-01-053-7366	BOLT 5E5314	11083	EA	4	4
40	53	PAHZZ	PAFZZ	PAHZZ	PAHZZ		.030	5330-00-945-0494	PACKING, P/O KIT P/N 6N1133 3M6309	11083	EA	1	1
40	54	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.005	3020-01-024-0102	GEAR 4N406	11083	EA	1	1
40	55	PAFZZ	PAFZZ	PAHZZ	PAHZZ	D	.008	2910-01-147-3000	BODY ASSY, TRANSFER PUMP 9L6863	11083	EA	1	1
40	56	PAHZZ	PAFZZ	PAHZZ	PAHZZ		.030	5330-01-061-9380	SEAL, LIP-TYPE, P/O KIT P/N 6N1133 4N1584	11083	EA	1	2
40	57	PAHZZ	PAFZZ	PAHZZ	PAHZZ		.030	5330-01-069-9381	SEAL, LIP-TYPE, P/O KIT P/N 6N1133 4N636	11083	EA	1	2
40	58	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.008	5315-00-406-7278	DOWEL 8S6814	11083	EA	1	3
40	59	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.005	5315-00-999-8416	SHAFT 8H9804	11083	EA	1	1
40	60	XA	XA	XA	XA				BODY 9L6788	11083	EA	1	1
40	61	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.005	3020-01-024-2915	GEAR 4N429	11083	EA	1	1
40	62	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.008	5315-01-068-9780	KEY 4N3779	11083	EA	1	1
40	63	PAHZZ	PAFFF	PAHZZ	PAHZZ	D	.009	2910-01-107-2419	CAMSHAFT 4N4313	11083	EA	1	1
40	64	PAFZZ	PAFZZ	PAFZZ	PAFZZ	D	.009	3040-01-148-8880	HOUSING ASSY 8N1570	11083	EA	1	1
40	65	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.015	5315-01-129-6772	PIN, SPRING 8N984	11083	EA	6	6
40	66	PAFZZ	PAFZZ	PAHZZ	PAHZZ	D	.009	2910-00-033-2200	VALVE ASSY 1P2298	11083	EA	1	1
40	67	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.008	5307-01-103-3673	STUD 4N3481	11083	EA	1	1
40	68	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.015	5315-01-068-9711	PIN, SPRING 4N2333	11083	EA	1	2
40	69	PAHZZ	PAFZZ	PAHZZ	PAHZZ	D	.008	5315-01-089-1410	DOWEL 4N1826	11083	EA	1	2
40	70	PAHZZ	PAFZZ	PAHZZ	PAHZZ		.030	5330-00-843-7194	PACKING, PREFORMED, P/O KIT P/N 6N1133 2D6392	11083	EA	1	2
40	71	XA	XA	XA	XB				HOUSING 4N256	11083	EA	1	1
40	72	PAHZZ	PAFZZ	PAHZZ	PAHZZ		.050	3110-01-062-0950	BEARING 6N1076	11083	EA	1	1
40	73	PAHZZ	PAFZZ	PAHZZ	PAHZZ		.050	3110-01-062-6770	BEARING 4N3711	11083	EA	1	1
40	74	XA	XA	XA	XA				HOUSING, FUEL INJECTION 4N145	11083	EA	1	1

**STANADYNE ROTARY PUMP**

**60KW GENERATOR SET**

ARMY TECHNICAL MANUAL  
AIR FORCE TECHNICAL ORDER  
NAVY PUBLICATION  
MARINE CORPS STOCK LIST

TM 9-6115-545-24P  
TO 35C2-3-444-4  
NAVFAC P-8-626-24P  
SL-400038G/07499A

---

TECHNICAL MANUAL

UNIT, DIRECT AND GENERAL SUPPORT, AND DEPOT  
MAINTENANCE REPAIR PARTS AND SPECIAL TOOLS LIST

GENERATOR SET, DIESEL ENGINE DRIVEN, TACTICAL, SKID RTD.,  
60 KW, 3 PHASE, 4 WIRE, 120/208 AND 240/416 VOLTS

DOD MODEL	CLASS	HERTZ	NSN
MEP-006A	UTILITY	50/60	6115-00-118-1243
MEP-105A	PRECISE	50/60	6115-00-118-1252
MEP-115A	PRECISE	400	6115-00-118-1253

INCLUDING OPTIONAL KITS

DOD MODEL	NOMENCLATURE	NSN
MEP-006AWF	WINTERIZATION KIT, FUEL BURNING	6115-00-407-8314
MEP-006AWE	WINTERIZATION KIT, ELECTRIC	6115-00-455-7693
MEP-006ALM	LOAD BANK KIT	6115-00-407-8322
MEP-006AWM	WHEEL MOUNTING KIT	6115-00-463-9092

DISTRIBUTION STATEMENT A: Approved for public release; distribution is unlimited.

This manual supersedes TM 5-6115-545-24P/TO 35C2-3-444-4/NAVFAC P-8-626-24P/SL-400038G/7499A, dated 27 December 1983, including all changes.

---

DEPARTMENTS OF THE ARMY, AIR FORCE,  
NAVY AND HEADQUARTERS, MARINE CORPS  
28 JUNE 1995

ALLIS CHALMERS 3500 ENGINE

282

**TM 9-6115-545-24P**  
**TO 35C2-3-444-4**  
**NAVFAC P-8-626-24P**  
**SL-400038G/07499A**

(1) ILLUSTRATION		(2) SMR CODE				(3) USMC		(4) NATIONAL STOCK NUMBER	(5) DESCRIPTION			(6)	(7)	(8)
(a) FIG NO.	(b) ITEM NO.	a ARMY	b AIR FORCE	c NAVY	d USMC	a SSI	b REPL FACTOR		REF NUMBER	MFR CODE	USABLE ON CODE	U/M	QTY INC IN UNIT	USMC QTY PER EQUIP
102	1	PAFZZ	PAOZZ	XBGZZ	PAHZZ	D	.008	2910-00-133-9877	INJECTION PUMP AND RELATED PARTS			EA	1	1
102	2	PAFZZ	PAOZZ	XBGZZ	PAHZZ	D	.015	5360-00-887-1536	BUTTON THRUST 16144 SPRING. EHL, COMPRESSION 10541 (84760)	(84760)		EA	1	1
102	3	PAFZZ	PAOZZ	XBGZZ	PAHZZ	D	.010	5310-00-407-5575	WASHER, LOCK 10534 (84760)	(84760)		EA	1	1
102	4	PAFZZ	PAOZZ	XBGZZ	PAHZZ	D	.008	5310-00-115-6223	NUT. PLAIN, HEX 10529 (84760)	(84760)		EA	1	1
102	5	PAFZZ	PAOZZ	XBGZ	PAHZZ	-	.005	3020-00-110-9616	GEAR. HELICAL 4025303 (6N299)	(6N299)		EA	1	1
102	6	PAFZZ	PAOZZ	XBGZZ	PAHZZ	D	.008	5315-01-056-3398	KEY 10274 (84760)	(84760)		EA	1	1
102	7	PAFZZ	PAOZZ	XBGZZ	PAHZZ	D	.008	5310-00-006-2434	NUT. PLAIN, HEX 0910324 (6N299)	(6N299)		EA	2	2
102	8	PAFZZ	PAOZZ	XBGZZ	PAHZZ	D	.010	5310-00-898-1477	WASHER, LOCK 4371718-0 (6N299)	(6N299)		EA	2	2
102	9	PAFHH	PAODD	POBGD	PAFHH	I	.180	2910-00-228-2799	PUMP, FUEL, METERING (SEE FIG 103 FOR BREAKDOWN) DCMFC629-2LQ (84760)	(84760)		EA	1	1
102	10	PAFZZ	PAOZZ	XBGZZ	PAFZZ	D	.008	5310-00-732-0559	NUT. PLAIN. HEX3/8-24 MS51968-8 (96906)	(96906)		EA	3	11
102	11	PAFZZ	PAOZZ	XBGZZ	PAFZZ	D	.010	5310-00-637-9541	WASHER, LOCK MS3533846 (96906)	(96906)		EA	3	155
102	12	PAFZZ	PAOZZ	XBGZZ	PAFZZ	D	.010		WASHER, FLAT (PART OF KIT NSN. 5330-00001-4948) 10519 (84760)	(84760)		EA	3	37
102	14	XBFZZ	XB	XBGZZ	XBHZZ				PLATE, RETAINING 4026004 (6N299)	(6N299)		EA	1	1
102	15	PAFZZ	PAOZZ	XBGZZ	PAHZZ	-	.008	2910-00-930-9358	ADAPTER, BEARING 4025249 (6N299)	(6N299)		EA	1	1
102	16	XBFZZ	XB	XBGZZ	XBHZZ				STUD, THREADED 4025250 (6N299)	(6N299)		EA	2	2
102	17	KFFZZ	PAOZZ	KFGZZ	KFFZZ			5330-00-890-3905	PACKING, PREFORMED (PART OF KIT NSN: 53300-0001-4949) 4255661 (6N299)	(6N299)		EA	1	1

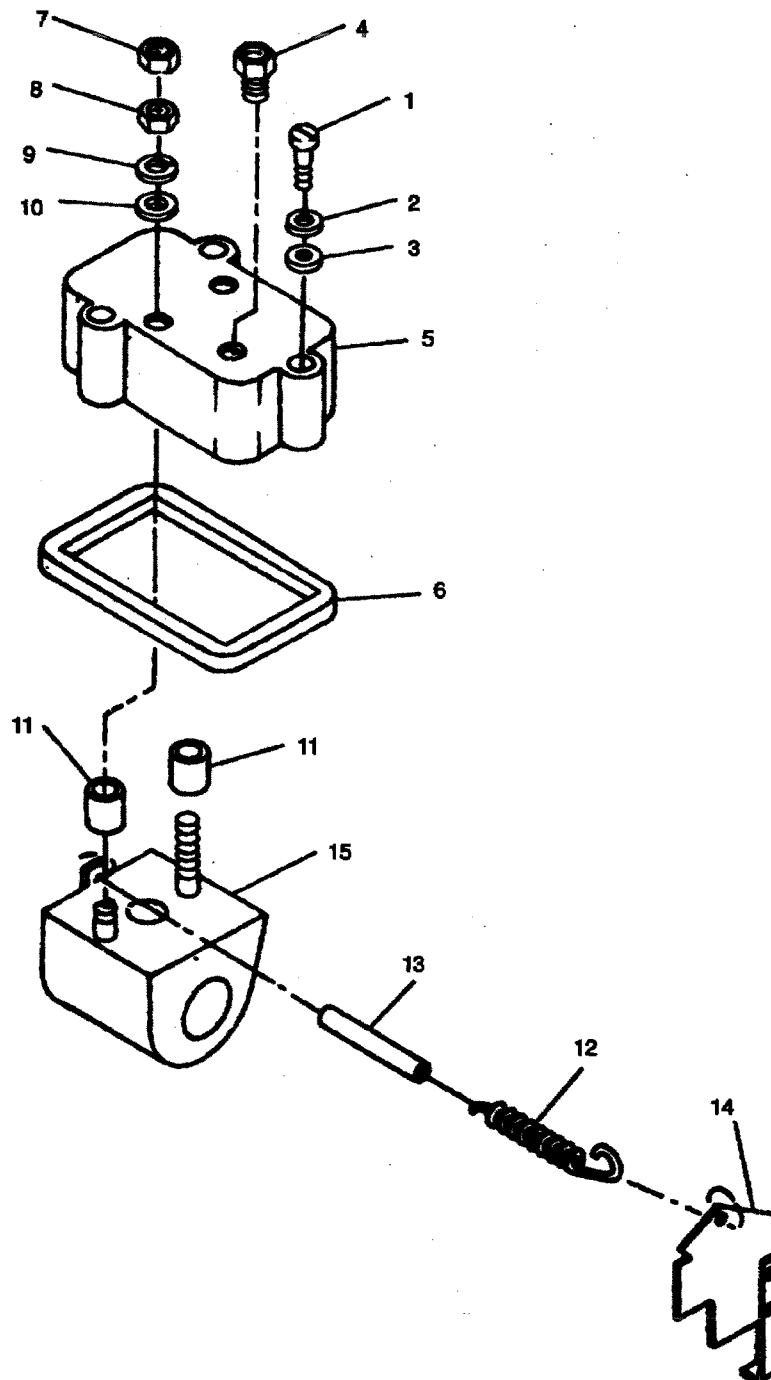


Figure 103. Pump, Fuel, Metering (Sheet 1 of 7).



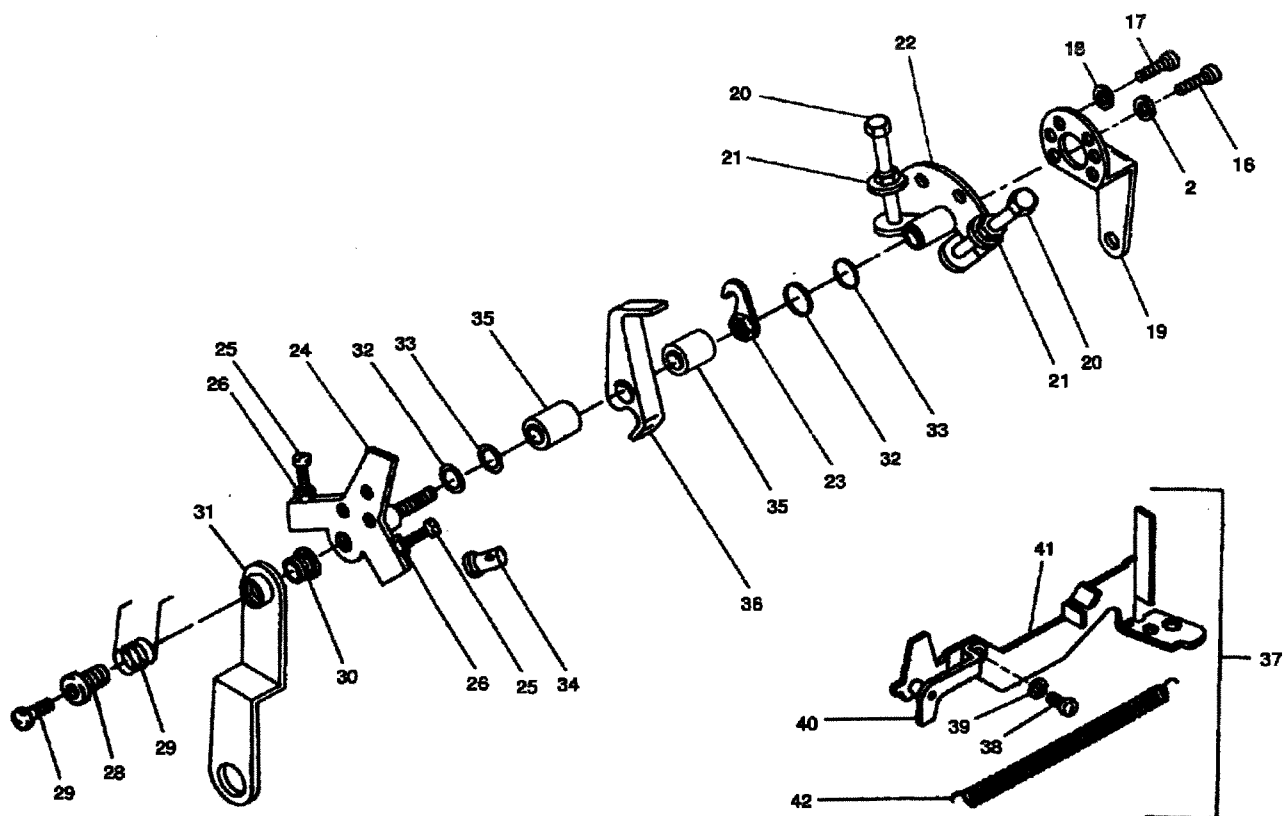


Figure 103. Pump, Fuel, Metering (Sheet 2 of 7).

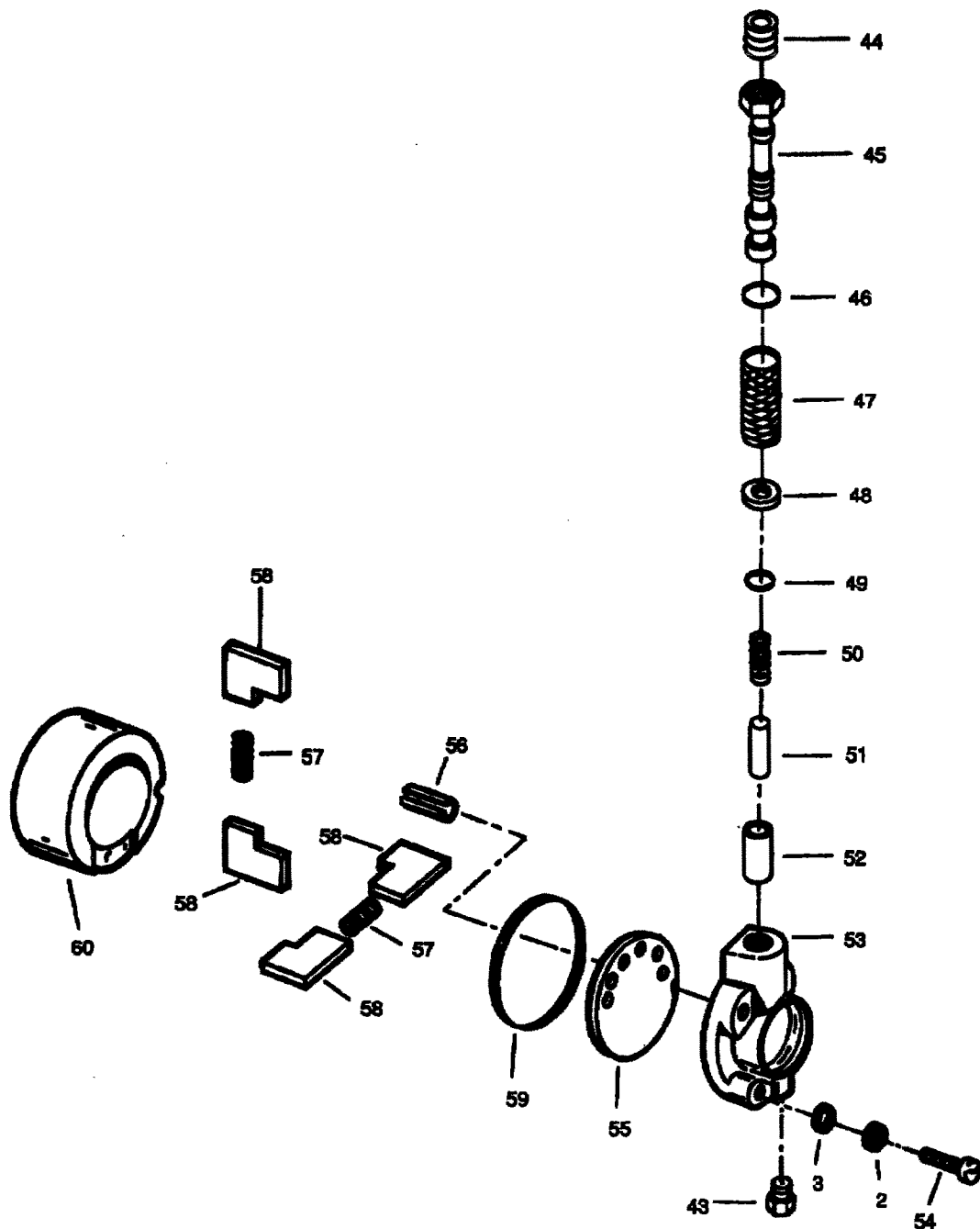


Figure 103. Pump, Fuel, Metering (Sheet 3 of 7).

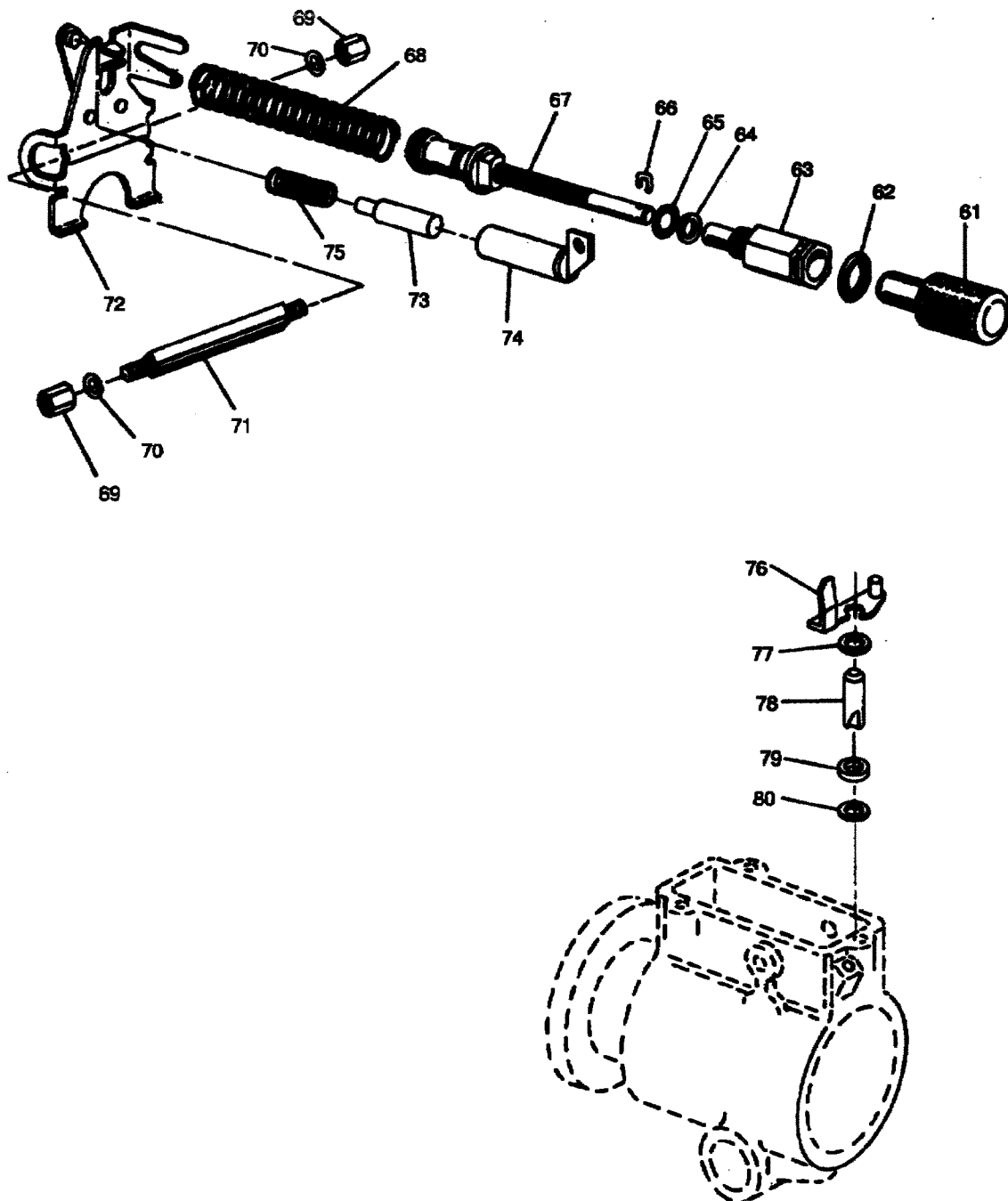


Figure 103. Pump, Fuel, Metering (Sheet 4 of 7).

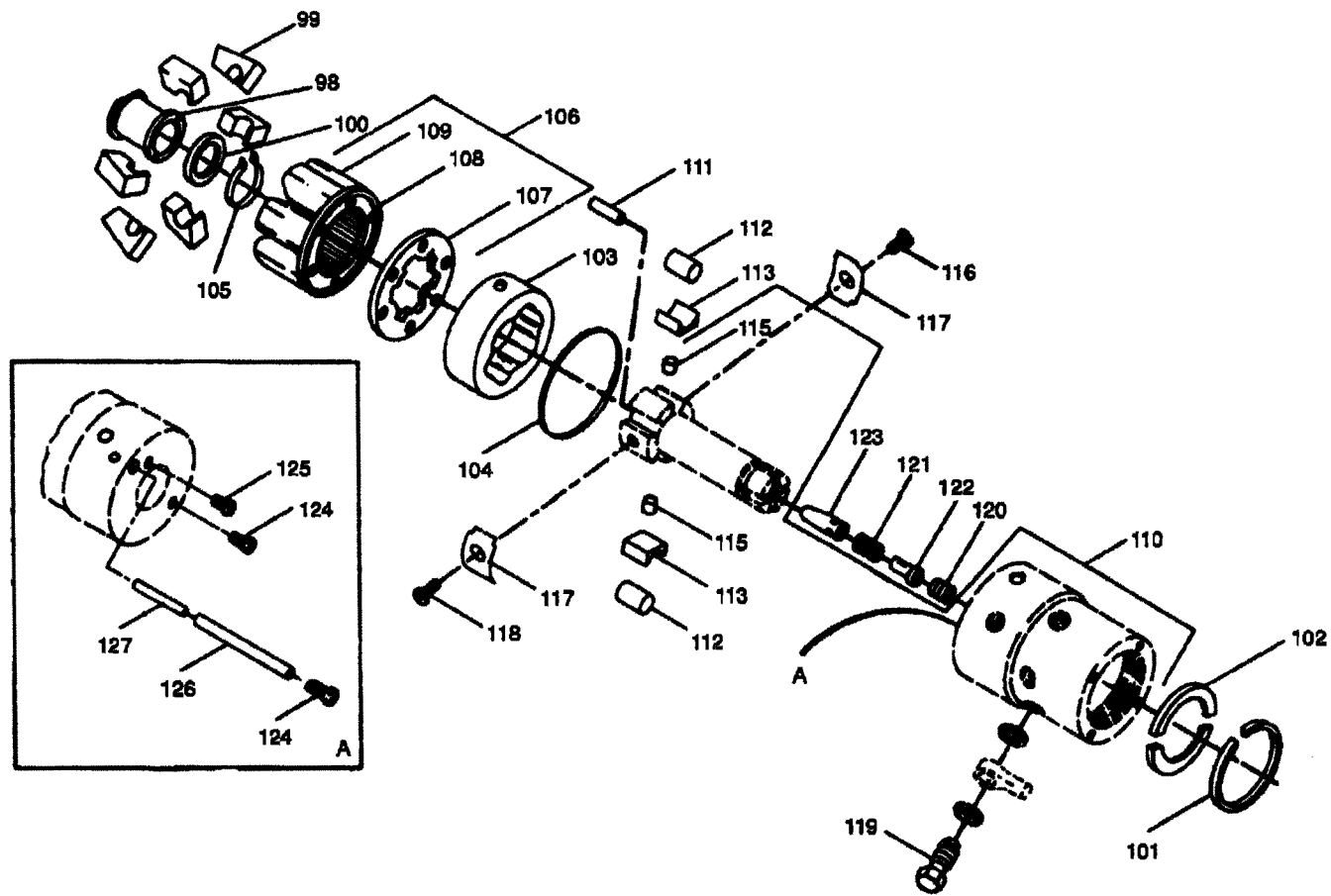


Figure 103. Pump, Fuel, Metering (Sheet 6 of 7).

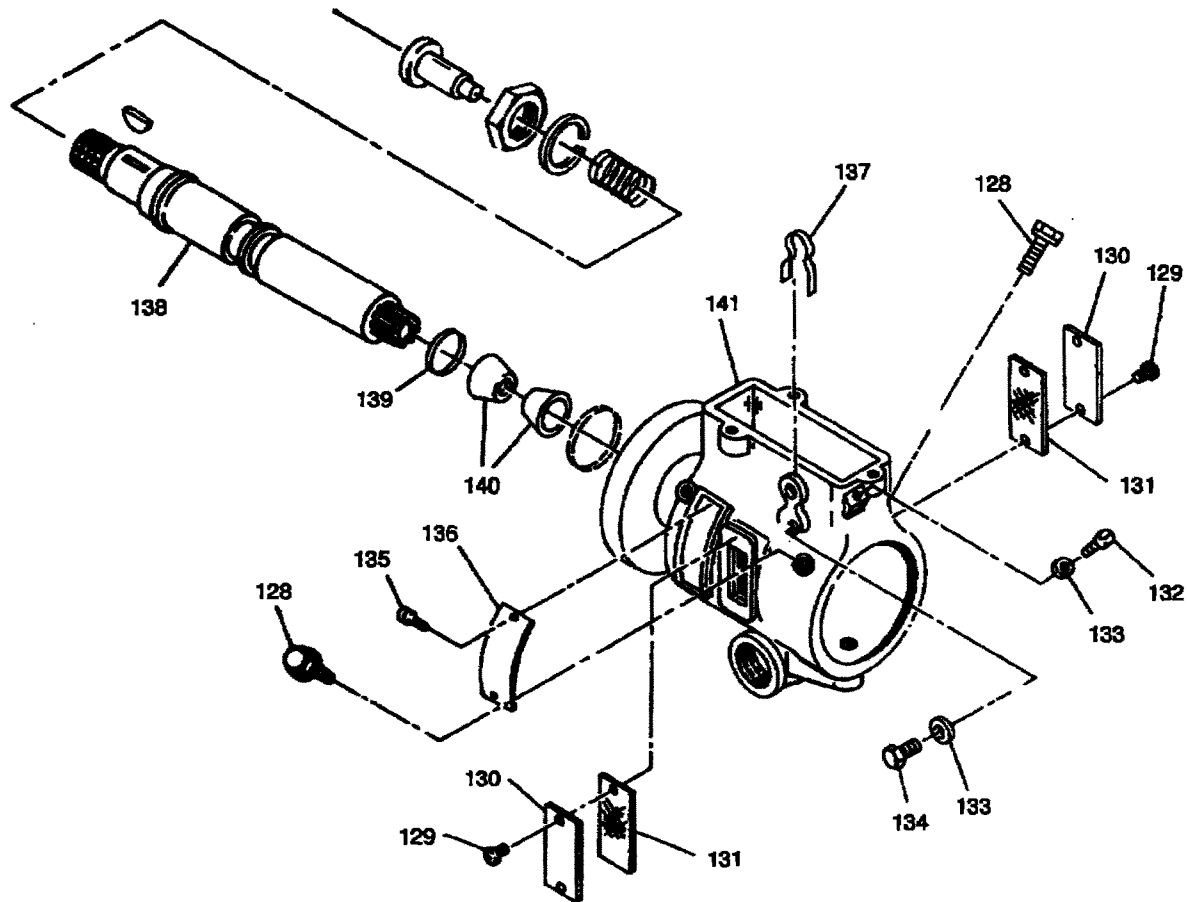


Figure 103. Pump, Fuel, Metering (Sheet 7 of 7).

**TM 9-6115-545-24P**  
**TO 35C2-3-444-4**  
**NAVFAC P-8-626-24P**  
**SL-400038G/07499A**

(1) ILLUSTRATION		(2) SMR CODE				(3) USMC		(4) NATIONAL STOCK NUMBER	(5) DESCRIPTION			(6)	(7)	(8)
(a) FIG NO.	(b) ITEM NO.	a ARMY	b AIR FORCE	c NAVY	d USMC	a SSI	b REPL FACTOR		REF NUMBER	MFR CODE	USABLE ON CODE	U/M	QTY INC IN UNIT	USMC QTY PER EQUIP
103		PAFHH	PAODD	PBGGD	PAFHH	I	.180	2910-00-228-2799	PUMP, FUEL METERING			EA	1	1
103	1	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.008	530500-846-0129	DCMFC629-2LO SCREW, MACHINE	(84760)		EA	3	3
103	2	PAHZZ	PADZZ	XBGZZ	PAHZ	D	.010	5310-00-209-1218	MS3526568 WASHER, LOCK	(96906)		EA	8	8
103	3	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.010	5310-00-194-0607	2239H WASHER, FLAT	(45152)		EA	7	7
103	4	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.008	4730-00-200-3412	779343 CONNECTOR ASSY	(79500)		EA	1	1
103	5	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.008	2910-00-3359329	20154 COVER, GOVERNOR CONTROL	(84760)		EA	1	1
103	6	KFHZZ	KD	KFGZZ	KFHZZ				12106 GASKET, GOVERNOR COVER	(84760)		EA	1	1
103	7	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.008	5310-00-582-5765	(PART OF KIT NSN 5330-00-401-5247) 27244 NUT, SELF-LOCKING, HEX	(84760)		EA	2	2
103	8	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.008	5310-00-934-9757	8527012 NUT, PLAIN, HEX	(18876)		EA	2	4
103	9	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.010	5310-00-190-0752	MS35649-282 WASHER, FLAT	(96906)		EA	2	2
103	10	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.010	5310-00-830-7825	10-9858 WASHER, SHOULDERED	(59501)		EA	2	2
103	11	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.008	5365-00-786-4025	12500 BUSHING, RUBBER	(84760)		EA	2	2
103	12	PAHZZ	PADZZ	XBGZZ	PAHZZ	I	.020	5360-00-691-7207	12513 SPRING, HELICAL EXTENSION	(84760)		EA	1	1
103	13	PAHZZ	PADZZ	XBGZZ	PAHZZ			536500-209-3148	12480 BUSHING, RUBBER	(84760)		EA	1	1
103	14	PAHZZ	PADZZ	XBGZZ	PAHZZ			2910-00-832-0122	16396 ARM ASSY PUMP	(84760)		EA	1	1
103	15	PAHZZ	PADZZ	XBGZZ	PAHZZ			2920-00-897-2459	16278 FRAME ASSY, SOLENOID	(84760)		EA	1	1
103	16	PAFZZ	PADZZ	XBGZZ	PAHZZ	D	.008	5305-01-007-1321	22316 SCREW, CAP. SOCKET HEAD	(84760)		EA	1	1
103	17	PAFZZ	PADZZ	XBGZZ	PAHZZ	D	.008	5305-00-978-9368	12996 SCREW, CAP. SOCKET HEAD	(84760)		EA	1	1
103	18	PAFZZ	PADZZ	PAGZZ	PAHZZ	D	.010	5310-00-559-0070	MS16997-30 WASHER, LOCK	(96906)		EA	1	5
103	19	XBFZZ	XB	XBGZZ	XBHZZ				MS35333-38 LEVER, ADJUST SHUNT	(96906)		EA	1	1
103	20	PAFZZ	PADZZ	XBGZZ	PAHZZ	D	.008	5305-00-891-8979	12979 SCREW, MACHINE	(84760)		EA	2	2
103	21	PAFZZ	PADZZ	XBGZZ	PAHZZ	D	.008	5310-00-935-1243	12972 NUT, PLAIN, HEX	(84760)		EA	2	2
103	22	PAFZZ	PADZZ	XBGZZ	PAHZZ	*	.020	2910-00-897-2545	12174 SHAFT ASSY	(84760)		EA	1	1
103	23	PAHZZ	PADZZ	XBGZZ	PAHZZ	-	.020	2910-00-066-2499	12237 CAM ASSY, SHUNT	(84760)		EA	1	1
103	24	PAHZZ	PADZZ	XBGZZ	PAHZZ	-	.020	2910-00-204-9549	14966 SHAFT ASSY, THROTTLE	(84760)		EA	1	1
103	25	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.006	5305-00-024-6276	17619 SCREW, CAP. SOCKET HEAD	(84760)		EA	2	2
103	26	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.010	5310-00-935-1243	18965 NUT, PLAIN HEX	(84760)		EA	1	3
103	27	PAHZZ	PADZZ	XBGZZ	PAHZZ			5305-01-238-3122	12174 SCREW, THROTTLE SPRING	(84760)		EA	1	1
103	28	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.008	5340-00-786-1550	12999 RETAINER, HELICAL	(84760)		EA	1	1

**TM 9-6115-545-24P**  
**TO 35C2-3-444-4**  
**NAVFAC P-8-626-24P**  
**SL-400038G/07499A**

(1) ILLUSTRATION		(2) SMR CODE				(3) USMC		(4) NATIONAL STOCK NUMBER	(5) DESCRIPTION			(6) U/M	(7) QTY INC IN UNIT	(8) USMC QTY PER EQUIP
(a) FIG NO.	(b) ITEM NO.	a ARMY	b AIR FORCE	c NAVY	d USMC	a SSI	b REPL FACTOR		REF NUMBER	MFR CODE	USABLE ON CODE			
103	29	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.040	5380-00-751-8916	SPRING, HELICAL 13003 (84760)			EA	1	1
103	30	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.008	530500-788-3735	SCREW, MACHINE 12957 (84760)			EA	1	2
103	31	XBHZZ	XB	XBGZZ	XBHZZ	-	.008		LEVER ASSY 20283 (84760)			EA	1	1
103	32	KFHZZ	KD	KFGZZ	KFHZZ				WASHER, FLAT (PART OF KIT NSN: 533000-401-5247) 14408 (84760)			EA	2	2
103	33	KFHZZ	KD	KFGZZ	KFHZZ				PACKING, PREFORMED (PART OF KIT NSN: 5330-00-401-5247) 17438 (84760)			EA	3	3
103	34	XBHZZ	XB	XBGZZ	XBHZZ				CAP. IDLER, ADJ 17602 (84760)			EA	1	1
103	35	XBHZZ	XB	XBGZZ	XBHZZ				SPACER, THROTTLE 16587 (84760)			EA	2	2
103	37	PAHZZ	PADZZ	PAGZZ	PAHZZ	D	.020	2910-00-148-6557	HOOK, ASSY 20226 (84760)			EA	1	1
103	38	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.008	5305-00-250-5613	SCREW, MACHINE 12360 (84760)			EA	1	1
103	39	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.010	5310-00-400-8585	WASHER, SPRING 12362 (84760)			EA	1	1
103	40	PAHZZ	PADZZ	PAGZZ	PAHZZ	-	.008	3040-01-230-9081	LINKAGE ADJUST 20225 (84760)			EA	1	1
103	41	XAHZZ	XA	XBGZZ	XBHZZ				HOOK, GOVERNOR 17604 (84760)			EA	1	1
103	42	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.008	5360-00-335-9237	SPRING 11919 (84760)			EA	1	1
103	43	KFHZZ	KD	KFGZZ	KFHZZ				PLUG. PIPE (PART OF KIT NSN: 5330-00-401-5247) 15821 (84760)			EA	1	1
103	44	PAHZZ	PADZZ	XBGZZ	PAHZZ	-	.008	4730-00-459-6077	PLUG, ADJUSTABLE 15228 (84760)			EA	1	1
103	45	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.030	4730-00-897-2460	BOLT, FLUID PASSAGE 17058 (84760)			EA	1	1
103	46	KFHZZ	KD	KFGZZ	KFHZZ				PACKING, PREFORMED (PART OF KIT NSN: 5330-00-401-5247) 12406 (84760)			EA	1	2
103	47	PAHZZ	PADZZ	XBGZZ	PAHZZ	-	.020	2910-00-898-4926	ELEMENT, FILTER 15225 (84760)			EA	1	1
103	48	KFHZZ	KD	KFGZZ	KFHZZ				WASHER, FLAT (PART OF KIT NSN 5330-0-401-5247) 15627 (84760)			EA	1	1
103	49	KFHZZ	KD	KFGZZ	KFHZZ				PACKING, PREFORMED (PART OF KIT NSN 5330-00-401-5247) 11507 (84760)			EA	1	1
103	50	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.020	5360-00-418-4365	SPRING, HELICAL COMPRESSION 15913 (84760)			EA	1	1
103	51	PAHZZ	PADZZ	XBGZZ	PAHZZ	-	.008	2910-00-321-8737	PISTON, REGULATING 11508 (84760)			EA	1	1
103	52	KFHZZ	KD	KFGZZ	KFHZZ				SEAL, PISTON (PART OF KIT NSN 5330-00-401-5247) 17056 (84760)			EA	1	1
103	53	XBHZZ	XB	XBGZZ	XBHZZ	-	.008		PLATE, END 15877 (84760)			EA	1	1
103	54	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.008	5305-00-788-4028	SCREW, EXTERNAL 11532 (84760)			EA	4	14
103	55	PAOZZ	PADZZ	XBGZZ	PAHZZ	-	.008	2910-00-901-0753	THRUST, PLATE, FUEL 15875 (84760)			EA	1	1

**TM 9-6115-545-24P**  
**TO 35C2-3-444-4**  
**NAVFAC P-8-626-24P**  
**SL-400038G/07499A**

(1) ILLUSTRATION		(2) SMR CODE				(3) USMC		(4) NATIONAL STOCK NUMBER	(5) DESCRIPTION			(6)	(7)	(8)
(a) FIG NO.	(b) ITEM NO.	a ARMY	b AIR FORCE	c NAVY	d USMC	a SSI	b REPL FACTOR		REF NUMBER	MFR CODE	USABLE ON CODE	U/M	QTY INC IN UNIT	USMC QTY PER EQUIP
103	56	PAHZZ	PADZZ	XBGZZ	PAHZZ	-	.008	53500-992-7084	SPACER, SLEEVE 11525 (84760)			EA	1	1
103	57	PAHZZ	PADZZ	XBGZZ	PAHZZ	-	.008	530-00-900-2564	SPRING, HELICAL COMPRESSION 15699 (84780)			EA	2	2
103	58	PAHZZ	PADZZ	PAGZZ	PAHZZ	-	.020	2910-00148-6555	BLADE, TRANSFER PUMP 20804 (84760)			EA	4	4
103	59	00-401-5247)												
103	60	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.008	2910-00-208-974	11329 (84760) LINER, TRANSFER PUMP 18658 (84760)			EA	1	1
103	61	XBHZZ	XB	XBGZZ	XBHZZ				CAP ASSY 13567 (84760)			EA	1	1
103	62	KFHZZ	KD	KFGZZ	KFHZZ				PACKING, PREFORMED (PART OF KIT NSN: 5330-00-401-5247) 12966 (84760)			EA	1	1
103	63	XBHZZ	XB	XBGZZ	XBHZZ				GUIDE, CONTROL ROD 20223 (84760)			EA	1	1
103	64	PAHZZ	PADZZ	XBGZZ	PAHZZ			5310-00-877-4957	WASHER 13572 (84760)			EA	1	1
103	65	KFHZZ	KD	KFGZZ	KFHZZ				PACKING, PREFORMED (PART OF KIT NSN: 5330-00-401-5247) 13550 (84760)			EA	1	1
103	66	PAHZZ	PADZZ	XBGZZ	PAHZZ			5315-00-786-3998	PIN, LOCKING 13554 (84760)			EA	1	1
103	67	XBHZZ	XB	XBGZZ	XBHZZ				ROD ASSY, CONTROL 18275 (84760)			EA	1	1
103	68	XBHZZ	XB	XBGZZ	XBHZZ				SPRING, COMPRESSION 13558 (84760)			EA	1	1
103	69	PAHZZ	PADZZ	XBGZZ	PAHZZ			5310-00-791-9437	NUT, PLAIN, HEX 12288 (84760)			EA	2	2
103	70	KFHZZ	PADZZ	KFGZZ	KFHZZ			5330-00-641-8286	SEAL (PART OF KIT NSN: 5330-00-401-5247) 11588 (84760)			EA	2	2
103	71	XBHZZ	XB	XBGZZ	PAHZZ	I	.020		SHAFT, GOVERNOR 20224 (84760)			EA	1	1
103	72	XBHZZ	XB	XBGZZ	XBHZZ				ARM, GOVERNOR 20219 (84760)			EA	1	1
103	73	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.008	2910-00-780-0938	PISTON ASSY PUMP 16572 (84760)			EA	1	1
103	74	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.008	2910-00-200-3294	BARREL ASSY 16568 (84760)			EA	1	1
103	75	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.015	5360-01-032-3146	SPRING, HELICAL COMPRESSION 20475 (84760)			EA	1	1
103	76	XBHZZ	XB	XBCZZ	XBHZZ				ARM ASSY, METER 22134 (84760)			EA	1	1
103	77	PAHZZ	PADZZ	XBGZZ	PAHZZ	-	.008	5365-00-877-4952	SHIM 111610 (84760)			EA	1	1
103	78	PAHZZ	PADZZ	XBGZZ	PAHZZ	I	.020	2910-01-054-3816	METERING VALVE, FUEL 20849 (84760)			EA	1	1
103	79	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.008	5365-00-485-0097	SPACER, PLATE 16575 (84760)			EA	1	1
103	80	PAHZZ	PAOZZ	XBGZZ	PAHZZ			5130-01-014-6985	SHIM, METERING VALVE 16576 (84760)			EA	V	V
103	81	XBHZZ	XB	KBGZZ	PAHZZ	D	.008		PLUG, PISTON HOLE 15752 (84760)			EA	1	1
103	82	PAHZZ	PADZZ	XBGZZ	PAHZZ	-	.008	5330-00-974-6643	PACKING PREFORMED 12764 (84760)			EA	2	2
103	83	PAHZZ	PADZZ	PAGZZ	PAHZZ			5330-01-014-6985	PACKING, PREFORMED 20113 (84760)			EA	2	2



(1) ILLUSTRATION		(2) SMR CODE				(3) USMC		(4) NATIONAL STOCK NUMBER	(5) DESCRIPTION			(6)	(7)	(8)
(a) FIG NO.	(b) ITEM NO.	a ARMY	b AIR FORCE	c NAVY	d USMC	a SSI	b REPL FACTOR		REF NUMBER	MFR CODE	USABLE ON CODE	U/M	QTY INC IN UNIT	USMC QTY PER EQUIP
103	84	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.008	2910-00-453-6237	PISTON, ADVANCE, FUEL 17631 (84760)			EA	1	1
103	85	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.008	536500-459-6003	PLUG, MACHINE THREAD 15739 (84760)			EA	1	1
103	86	KFHZZ	KO	KFGZZ	KFHZZ				SEAL, ADVANCE (PART OF KIT NSN: 533000-401-5247) 12766 (84760)			EA	1	1
103	87	PAHZZ	PADZZ	XBGZZ	PAHZZ	-	.008	5315-00-128-1186	PIN, ADVANCE 15740 (84760)			EA	1	1
103	88	PAHZZ	PADZZ	XBGZZ	PAHZZ	I	.020	482000-432-1232	CARTRIDGE, RELIEF VALVE 22238 (84760)			EA	1	1
103	89	KFHZZ	KD	KFGZZ	KFHZZ				GASKET (PART OF KIT NSN: 5330-00-401-5247) 15750 (84760)			EA	1	1
103	90	PAHZZ	PADZZ	XBGZZ	PAHZZ	-	.008	2910-00-932-4787	RING, FUEL INJECTOR 18967 (84760)			EA	1	1
103	91	PAHZZ	PADZZ	XBGZZ	PAHZZ	-	.008	5360-00-058-6555	SPRING, HELICAL COMPRESSION 12685 (84760)			EA	1	1
103	92	XBHZZ	XB	XBGZZ	XBHZZ				WASHER, SPRING 17634 (84760)			EA	1	1
103	93	XBHZZ	XB	XBGZZ	XBHZZ				RING, ADVANCE SPRING 17635 (84760)			EA	1	1
103	94	XBHZZ	XB	XBGZZ	XBHZZ				PLUG, PISTON 18972 (84760)			EA	1	1
103	95	XBHZZ	XB	XBGZZ	XBHZZ				SCREW, ADVANCE 21721 (84760)			EA	1	1
103	96	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.008	531000-891-5703	NUT, PLAIN, HEX 13807 (84760)			EA	1	1
103	97	PAHZZ	PADZZ	XBGZZ	PAHZZ		.008	291000-128-1185	CAP, ADJUSTING SCREW 11611 (84760)			EA	1	1
103	98	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.008	291001-117-7252	BEARING, SLEEVE 21312 (84760)			EA	1	1
103	99	PAHZZ	PADZZ	XBGZZ	PAHZZ			2910-00-209-1528	WEIGHT, GOVERNOR 20214 (84760)			EA	6	6
103	100	PAHZZ	PADZZ	XBGZZ	PAHZZ			3120-00-393-4067	WASHER, GOVERNOR 20222 (84760)			EA	1	1
103	101	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.008	536500-786-4027	RING, RETAINING 11208 (84760)			EA	1	1
103	102	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.008	536500-786-3964	SPACER, PLATE 11212 (84760)			EA	2	2
103	103	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.009	2910-00-780-1824	CAM, RING FUEL PUMP 21688 (84760)			EA	1	1
103	104	KFHZZ	KD	KFGZZ	KFHZZ				PACKING, PREFORMED (PART OF KIT NSN: 5330-00-401-5247) 11304 (84760)			EA	1	1
103	105	PAHZZ	PADZZ	XBGZZ	PAHZZ	D	.008	536500-128-1189	RING, RETAINING 15835 (84760)			EA	1	1
103	106	PAHZZ	PADZZ	PAGZZ	PAHZZ	D	.020	2910-00-148-6556	WEIGHT, RETAINER ASSY 20229 (84760)			EA	1	1
103	107	KFHZZ	KD	KFGZZ	KFHZZ				RETAINER, PACKING (PART OF KIT NSN: 533000-401-5247) 17513 (84760)			EA	1	1
103	108	XAHZZ	XA	XBGZZ	XAHZZ				HUB ASSY PUMP 19536 (84760)			EA	1	1
103	109	XAHZZ	XA	XBGZZ	XAHZZ				RETAINER ASSY 20227 (84760)			EA	1	1
103	110	XBHZZ	XA	XAGZZ	XAHZZ				HYDRAULIC HEAD AND ROTOR ASSEMBLY 20155 (84760)			EA	1	1
103	111	XBHZZ	XB	XBGZZ	XBHZZ				PIN, ROTOR 15345 (84760)			EA	1	1

TM 9-6115-545-24P  
TO 35C2-3-444-4  
NAVFAC P-8-626-24P  
SL-400038G/07499A

[illegible]

**STANADYNE ROTARY PUMP**

**30KW GENERATOR SET**

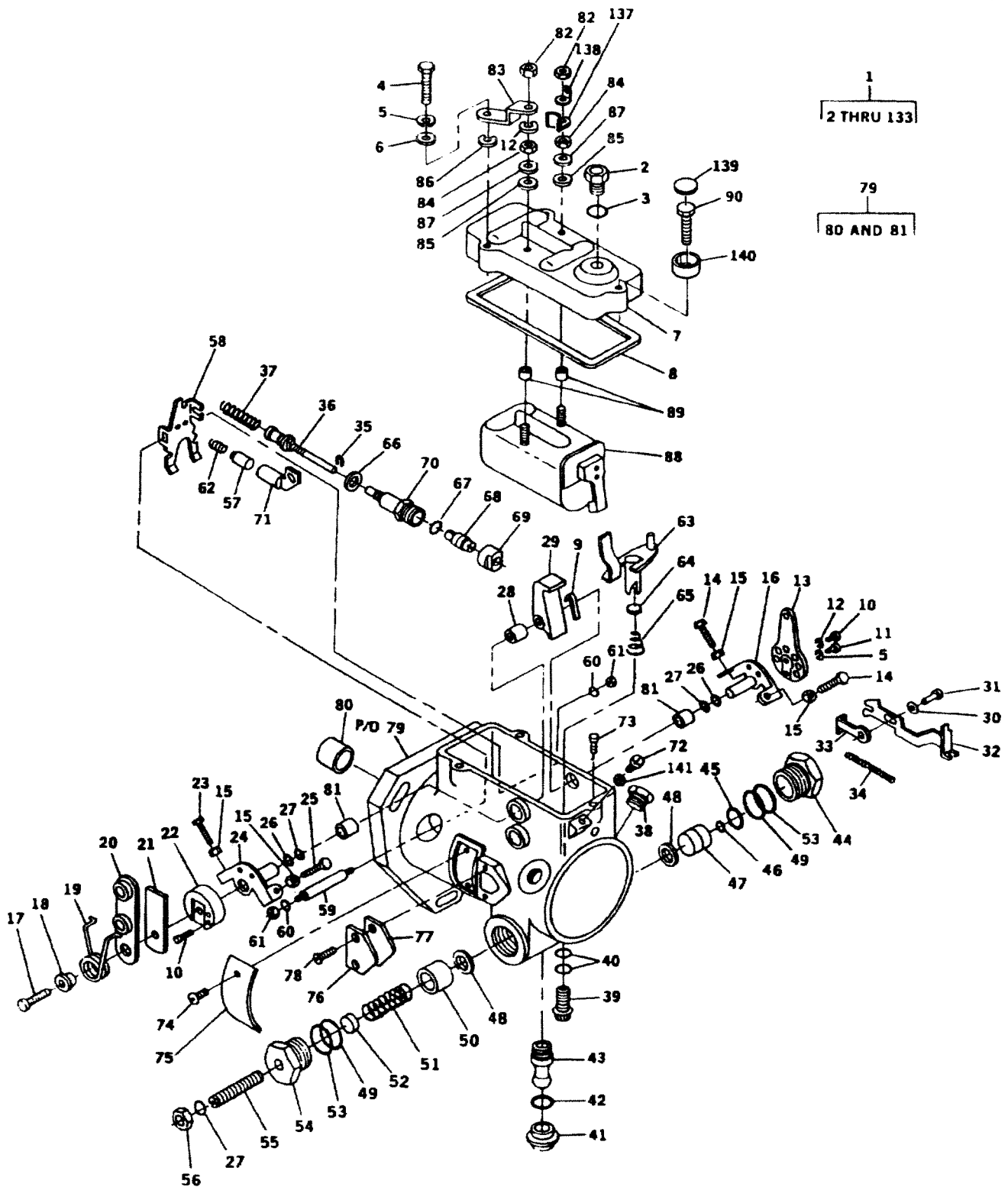


FIGURE 18. Fuel Injection Pump (Sheet 1 of 2)

JOHN DEERE 4039 T  
30 KW GEN TQ

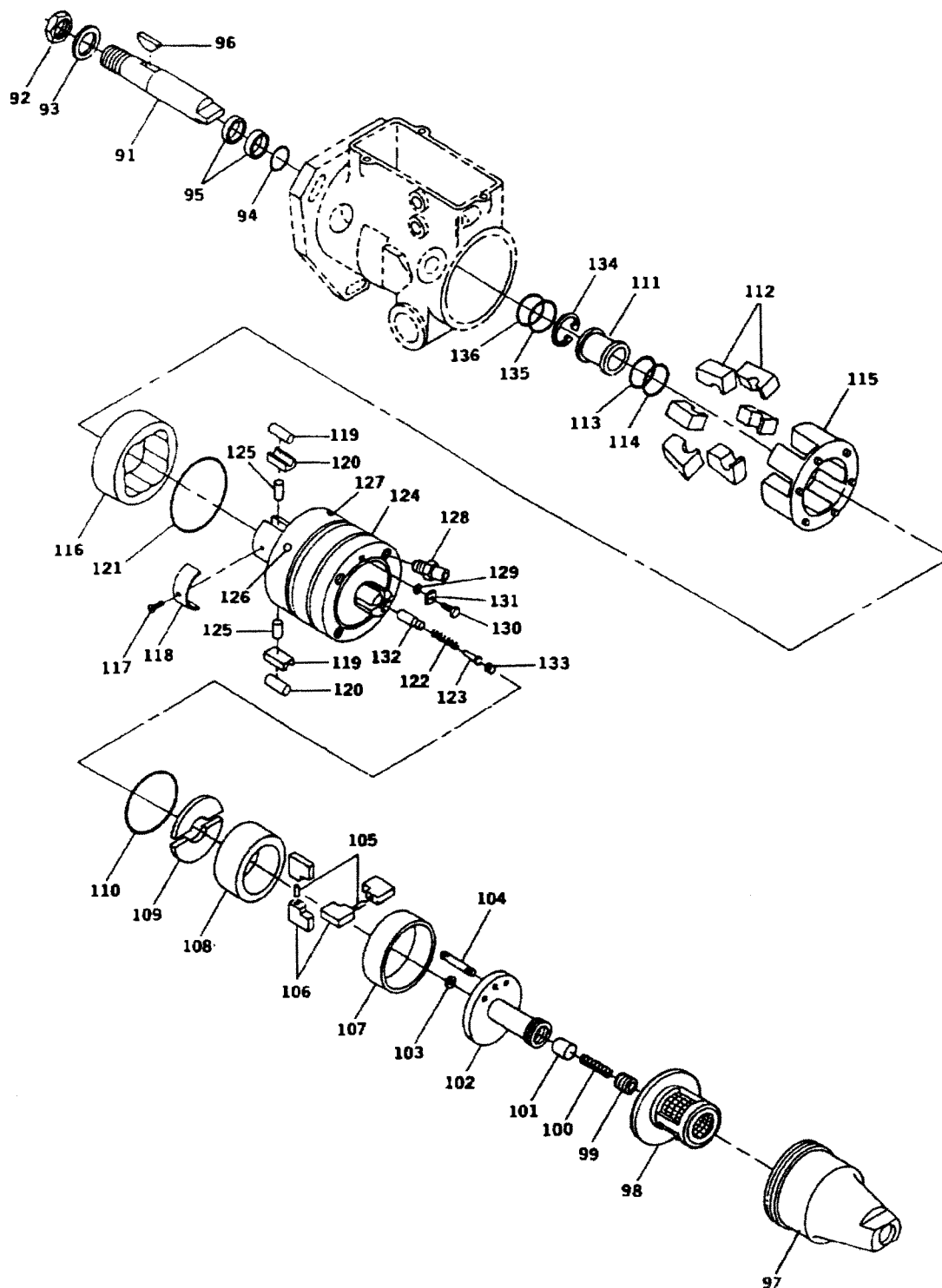


FIGURE 18. Fuel Injection Pump (Sheet 2 of 2)

ARMY TM 9-2815-255-24P  
AIR FORCE TO 38G1-95-4  
MARINE CORPS TM 2815-24P/2

(1)	(2)				(3)	(4)	(5)	(6)	(7)
ITEM	a.	b.	c.	d.	PART	DESCRIPTION AND			USMC
NO.	ARMY	AIR	NAVY	USMC	FSCM	NUMBER	USABLE ON CODE (UOC)	QTY	PER
									QTY EQUIP
							GROUP 05 - FUEL SYSTEM		
							FIG. 18 FUEL INJECTION PUMP		
1	PAFHH	PAFHH		PAFHH	84760	04806	PUMP, FUEL, METERING	1	1
2	XDHZZ	XA		XBHZZ	78514	21251	.CONNECTOR ASSY.	1	1
3	PAHZZ	PAOZZ		PAHZZ	84760	27607 <i>Viton</i>	.O-RING, PART OF KIT P/N 24373	1	1
4	PAHZZ	PAOZZ		PAHZZ	96906	MS35265-68	.SCREW, MACHINE	2	2
5	PBHZZ	PBOZZ		PBHZZ	84760	11582	.WASHER, LOCK	3	3
6	PBHZZ	PBOZZ		PBHZZ	OBND4	13521	.WASHER, FLAT	3	3
7	XDHZZ	XA		XBHZZ	84760	21898	.COVER, ACCESS	1	1
8	PAHZZ	PAOZZ		PAHZZ	84760	27244 <i>Viton</i>	.GASKET, PART OF KIT P/N 24373 ✓	1	1
9	XDHZZ	XA		XBHZZ	84760	14966	.CAM ASSEMBLY, SHUT	1	1
10	PAHZZ	PAOZZ		PAHZZ	96906	MS16997-30	.SCREW, CAP, SOCKET HE	2	2
11	XDHZZ	XA		XBHZZ	78514	12998	.SCREW, ADJ. SHUT-OF	1	1
12	PBHZZ	PBOZZ		PBHZZ	OBND4	12049	.WASHER, LOCK	2	2
13	XDHZZ	XA		XBHZZ	84760	12985	.LEVER, THROTTLE ADJ	1	1
14	XDHZZ	XA		XBHZZ	84760	12972	.SCREW, MACHINE	2	2
15	PAHZZ	PAOZZ		PAHZZ	84760	12174	.NUT, PLAIN, HEXAGON	4	4
16	XDHZZ	XA		XBHZZ	84760	16247	.SHAFT ASSEMBLY, SHUT	1	1
17	PBHZZ	PBOZZ		PBHZZ	84760	15668	.SCREW, CAP, SOCKET HE	1	1
18	PBHZZ	PBOZZ		PBHZZ	84760	13010	.RETAINER, HELICAL CO	1	1
19	PAHZZ	PAOZZ		PAHZZ	84760	1323	.SPRING, HELICAL, TORS	1	1
20	XDHZZ	XA		XBHZZ	84760	16392	.LEVER, ASSEMBLY	1	1
21	XDHZZ	XA		XBHZZ	84760	16136	.ARM, ADJUSTING	1	1
22	XDHZZ	XA		XBHZZ	78514	16135	.SPACER, THROTTLE	1	1
23	PBHZZ	PBOZZ		PBHZZ	84760	12167	.SCREW	1	1
24	PAHZZ	PAOZZ		PAHZZ	OBND4	12019	.SHAFT ASSY, THROTTLE	1	1
25	PBHZA	PBHZA		PBHZA	84760	12169	.SCREW, MACHINE	1	1
26	XDHZZ	XA		XBHZZ	OBND4	14408	.WASHER, FLAT, PART OF KIT P/N 24373	2	2
27	<del>PBHZZ</del>	<del>PBOZZ</del>		<del>PBHZZ</del>	<del>OBND4</del>	<del>17438</del> ✓	<del>.SEAL RING, METAL, PART OF KIT P/N 24373</del>	<del>3</del>	<del>3</del>
28	XDHZZ	XA		XBHZZ	78514	16587	.SPACER, THROTTLE	1	1
29	XDHZZ	XA		XBHZZ	84760	12221	.LEVER, THROTTLE	1	1
30	PBHZZ	PBOZZ		PBHZZ	OBND4	12362	.WASHER, FLAT	1	1
31	PAHZZ	PAOZZ		PAHZZ	84760	12360	.SCREW, MACHINE	1	1
32	PBHZZ	PBOZZ		PBHZZ	75755	R48516	.HOOK, GOVERNOR LINKA	1	1
33	XDHZZ	XA		XBHZZ	84760	20225	.CONNECTING LINK	1	1
34	PAHZZ	PAOZZ		PAHZZ	84760	11919	.SPRING, HELICAL, EXTE	1	1

ARMY TM 9-2815-255-24P  
AIR FORCE TO 38G1-95-4  
MARINE CORPS TM 2815-24P/2

(1)	(2)		(3)	(4)	(5)	(6)	(7)	
ITEM	a.	SMR	CODE	d	PART	DESCRIPTION AND	USMC	
NO.	ARMY	AIR	NAVY	USMC	FSCM	NUMBER	QTY	
		FORCE				USABLE ON CODE (UOC)	PER EQUIP	
35	XDHZZ	XA		XBHZZ	78514	13554	.PIN, CONTROL SPRING	1 1
36	XDHZZ	XA		XBHZZ	78514	2024C	.ROD ASSEMBLY, CONTRO	1 1
37	XDHZZ	XA		XBHZZ	78514	13558	.SPRING, CONTROL	1 1
38	PAHZZ	PAOZZ		PAHZZ	84760	11331	.BOLT, MACHINE	2 2
39	XDHZZ	XA		XBHZZ	78514	22238	.SCREW	1 1
40	PBHZZ	PBOZZ		PBHZZ	84760	27602 viton	.O-RING , PART OF KIT P/N 24373	2 2
41	XDHZZ	XA		XBHZZ	78514	23056	.PLUG	1 1
42	XDHZZ	XA		XBHZZ	78514	27610 viton	.SEAL, PART OF KIT P/N 24373	1 1
43	XDHZZ	XA		XBHZZ	78514	15438	.SCREW, CAM ADVANCE	1 1
44	XDHZZ	XA		XBHZZ	78514	22655	.PLUG, PISTON HOLE	1 1
45	PBHZZ	PBOZZ		PBHZZ	OBND4	18967	.RING, PISTON	1 3
46	PAHZZ	PAOZZ		PAHZZ	60764	639064 29281	.RETAINER, PACKING, PART OF KIT PIN 24373	1 1
47	XDHZZ	XA		XBHZZ	78514	22658	.PISTON, POWER	1 1
48	XDHZZ	XA		XBHZZ	78514	12622	.WASHER, SLIDE	2 2
49	PAHZZ	PAOZZ		PAHZZ	60764	639059 29280	.O-RING , PART OF KIT P/N 24373	2 2
50	XDHZZ	XA		XBHZZ	78514	27907	. PISTON, SPRING ,	1 1
51	XDHZZ	XA		XBHZZ	78514	18959	.SPRING	1 1
52	XDHZZ	XA		XBHZZ	78514	1494C	.GUIDE, ADV. ADJ.	1 1
53	PAHZZ	PAOZZ		PAHZZ	78514	18967 29282	.PACKING, PREFORMED , PART OF KIT P/N 24373	2 2
54	XDHZZ	XA		XBHZZ	78514	14941	.PLUG, PISTON	1 1
55	PBHZZ	PBOZZ		PBHZZ	84760	14544	.SETSCREW	1 1
56	PBHZZ	PBOZZ		PBHZZ	OBND4	13807	.NUT, SELF-LOCKING, HE	1 1
57	XDHZZ	XA		XBHZZ	78514	16572	.PISTON ASSEMBLY	1 1
58	XDHZZ	XA		XBHZZ	78514	20219	.ARM, GOVERNOR	1 1
59	PBHZZ	PBOZZ		PBHZZ	84760	20224	.SHAFT, GOVERNOR	1 1
60	PBHZZ	PBOZZ		PBHZZ	84760	31332	.O-RING , PART OF KIT P/N 24373	2 2
61	PBHZZ	PBOZZ		PBHZZ	OBND4	12288	.NUT, SELF-LOCKING, RO	2 2
62	XDHZZ	XA		XBHZZ	78514	20475	.SPRING, DAMPER	1 1
63	XDHZZ	XA		XBHZZ	78514	11563	.VALVE ASSY, METER	1 1
63	XDHZZ	XA		XBHZZ	78514	22248	.VALVE ASSY, METERING OVERSIZE	1 1
64	XAHHZ	XAHHZ		XAHHZ	OBND4	26427	.. SHIM	1 1
65	XAHHZ	XAHHZ		XAHHZ	84760	20359	.. SPRING, HELICAL, COMP	1 1
66	XDHZZ	XA		XBHZZ	OBND4	27606	.WASHER, SEAL , PART OF KIT P/N 24373	2 2
67	XDHZZ	XA		XBHZZ	78514	12966	.SEAL	1 1
68	XDHZZ	XA		XBHZZ	78514	20243	.CAP ASSEMBLY	1 1

**ARMY TM 9-2815-255-24P**  
**AIR FORCE TO 38G1-95-4**  
**MARINE CORPS TM 2815-24P/2**

(1)	(2)		(3)	(4)	(5)	(6)	(7)
ITEM	a.	SMR	CODE	d	PART	DESCRIPTION AND	USMC
NO.	ARMY	AIR	c	USMC	NUMBER	USABLE ON CODE (UOC)	QTY PER EQUIP
69	XDHZZ	XA		XBHZZ	3B788 20355	.CAP, DROOP CONTROL	1 1
70	PBHZZ	PBOZZ		PBHZZ	84760 27599	.ROD, STRAIGHT, HEADLE	1 1
71	PAHZZ	PAOZZ		PAHZZ	84760 16568	.BARREL ASSEMBLY DAM	1 1
72	XDHZZ	XA		XBHZZ	78514 12259	.SCREW	1 1
73	PAHZZ	PAOZZ		PAHZZ	84760 21661	.SCREW, ASSY. VENT #1	1 1
73	PAHZZ	PAOZZ		PAHZZ	84760 21662	.SCREW ASSY., VENT #2	1 1
73	PAHZZ	PAOZZ		PAHZZ	84760 21663	.SCREW ASSY. VENT #3	1 1
73	PAHZZ	PAOZZ		PAHZZ	84760 21664	.SCREW ASSY. VENT #4	1 1
73	PAHZZ	PAOZZ		PAHZZ	84760 21665	.SCREW ASSY. VENT #5	1 1
73	PBHZZ	PBOZZ		PBHZZ	34623 5740572	.SCREW ASSY., VENT	1 1
74	XDHZZ	XA		XBHZZ	78514 24419	.SCREW, NAME PLATE	2 2
75	XDHZZ	XA		XBHZZ	78514 10394	.PLATE, NAME	1 1
76	XDHZZ	XA		XBHZZ	78514 23107 <i>W</i>	.COVER, TIMING LINE	1 1
77	XDHZZ	XA		XBHZZ	78514 27603 <i>W</i>	.GASKET	1 1
78	PAHZZ	PAOZZ		PAHZZ	84760 21194	.SCREW, MACHINE	2 2
79	XDHZZ	XA		XBHZZ	78514 27974	.HOUSING ASSEMBLY	1 1
80	PBHZZ	PBOZZ		PBHZZ	84760 23382	.BUSHING, MACHINE	1 1
81	PBHZZ	PBOZZ		PBHZZ	84760 24364	.SLEEVE	2 2
82	PBHZZ	PBOZZ		PBHZZ	OBND4 14760	.NUT, SELF-LOCKING, RO	2 2
83	XDHZZ	XA		XBHZZ	78514 20951	.STRAP, TERMINAL	1 1
84	PBHZZ	PBOZZ		PBHZZ	OBND4 12519	.NUT, PLAIN, ROUND	2 2
85	PBHZZ	PBOZZ		PBHZZ	OBND4 12500	.INSULATOR, WASHER	1 2
86	PAHZZ	PAOZZ		PAHZZ	84760 18493	.WASHER, LOCK	1 1
87	PBHZZ	PBOZZ		PBHZZ	OBND4 18501	.WASHER, FLAT	2 2
88	PAHZZ	PAOZZ		PAHZZ	84760 26387	.FRAME ASSEMBLY, SOLE	1 1
89	XDHZZ	XA		XBHZZ	78514 23190 ✓	.STUD PART OF KIT P/N 24373	2 2
90	PBHZZ	PBOZZ		PBHZZ	84760 22351	.SCREW, MACHINE	1 1
91	XDHZZ	XA		XBHZZ	78514 27639	.SHAFT, DRIVE	1 1
92	XDHZZ	XA		XBHZZ	78514 26346	.NUT, DRIVE SHAFT	1 1
93	PBHZZ	PBOZZ		PBHZZ	78514 32787	.WASHER, FLAT	1 1
94	XDHZZ	XA		XBHZZ	78514 23367 ✓	.SEAL, PILOT TUBE	1 1
95	XDHZZ	XA		XBHZZ	78514 10453 ✓ <i>W</i>	.SEAL, DRIVE SHAFT, PART OF KIT P/N 24373	2 2
96	XDHZZ	XA		XBHZZ	78514 30387	.KEY, DRIVE SHAFT	1 1
97	PBHZZ	PBOZZ		PBHZZ	OBND4 20525	.HOUSING, LIQUID PUMP	1 1
98	PBHZZ	PBOZZ		PBHZZ	OBND4 26617	.STRAINER ELEMENT, SE	1 1
99	XDHZZ	XA		XBHZZ	78514 15228	.PLUG ASSY.	1 1
100	XDHZZ	XA		XBHZZ	78514 19855	.SPRING, REGULATING	1 1
101	XDHZZ	XA		XBHZZ	84760 19895	.PISTON, VALVE	1 1
102	XDHZZ	XA		XBHZZ	84760 28987	.VALVE, REGULATING	1 1



ARMY TM 9-2815-255-24P  
AIR FORCE TO 38G1-95-4  
MARINE CORPS TM 2815-24P/2

(1)	(2)	(3)	(4)	(5)	(6)	(7)
ITEM	SMR	CODE				USMC
NO.	a.	b.	c.	d.	PART	QTY
	ARMY	AIR	NAVY	USMC	NUMBER	PER
		FORCE		FSCM		EQUIP
					DESCRIPTION AND	
					USABLE ON CODE (UOC)	
103	XDHZZ	XA		XBHZZ 84760	19844 VITON	1 1
					.O-RING , PART OF KIT P/N 24373	
104	PBHZZ	PBOZZ		PBHZZ OBND4 19837	.PIN, SPRING	1 1
105	PAHZZ	PAOZZ		PAHZZ 84760 15699	.SPRING, HELICAL, COMP	2 2
106	XDHZZ	XA		XBHZZ 78514 20803	.BLADE, TRANSFER	4 4
107	PBHZZ	PBOZZ		PBHZZ OBND4 20528	.RING, WEARING	1 1
108	PBHZZ	PBOZZ		PBHZZ OBND4 22988	.LINING, FRICTION	1 1
109	XDHZZ	XA		XBHZZ 78514 20530	.RETAINER, ROTOR	2 2
<del>110</del>	<del>PAHZZ</del>	<del>PAOZZ</del>		<del>PAHZZ 84760 27245</del>	<del>.O-RING , PART OF KIT P/N 24373</del>	<del>2 2</del>
110	PAHZZ	PAOZZ		PAHZZ 84760 27608 VITON	.O-RING, PART OF KIT P/N 24373	1 1
111	XDHZZ	XA		XBHZZ 78514 14483	.SLEEVE, GOVERNOR	1 1
112	XDHZZ	XA		XBHZZ 78514 20214	.WEIGHT, GOVERNOR	6 6
113	XDHZZ	XA		XBHZZ 78514 20222	.WASHER, THRUST	1 1
114	XDHZZ	XA		XBHZZ 78514 12285	.RING, RETAINING	1 1
115	XDHZZ	XA		XBHZZ 78514 28681	.RETAINER, WEIGHT, GOV	1 1
116	XDHZZ	XA		XBHZZ 78514 21687	.RING, CAM	1 1
117	XDHZZ	XA		XBHZZ 78514 11175	.SCREW	1 1
118	XDHZZ	XA		XBHZZ 78514 27139	.SPRING, LEAF	1 1
119	PBHZZ	PBOZZ		PBHZZ OBND4 11141	.ROLLER, LINEAR-ROTAR	2 2
120	XDHZZ	XA		XBHZZ 78514 24569	.SHOE, CAM ROLLER	2 2
121	PAHZZ	PAOZZ		PAHZZ 84760 27245 VITON	.O-RING , PART OF KIT P/N 24373	1 1
122	XDHZZ	XA		XBHZZ 78514 16441	.SPRING	1 1
123	XDHZZ	XA		XBHZZ 78514 16440	.STOP, VALVE , PART OF KIT P/N 24373	1 1
124	XDHZZ	XA		XBHZZ 78514 32100	.HYD.HEAD&ROTOR ASSY	1 1
125	XDHZZ	XA		XBHZZ 78514 11086	..PLUNGER, ROTOR BASIC	2 2
125	XDHZZ	XA		XBHZZ 78514 11087	.. PLUNGER ROTOR STANDARD SIZE ,350 CODE A.	2 2
125	XDHZZ	XA		XBHZZ 78514 11088	..PLUNGER ROTOR STANDARD SIZE .350 CODE B.	2 2
125	XDHU	XA		XBHZZ 78514 11089	PLUNGER ROTOR STANDARD SIZE ,350 CODE C.	2 2
125	XDHZZ	XA		XBHZZ 78514 11090	PLUNGER ROTOR STANDARD SIZE ,350 CODE D.	2 2
125	XDHZZ	XA		XBHZZ 78514 11097	PLUNGER ROTOR OVERSIZE ,350 CODE A.	2 2
125	XDHZZ	XA		XBHZZ 78514 11098	PLUNGER ROTOR OVERSIZE .350 CODE B.	2 2

**ARMY TM 9-2815-255-24P**  
**AIR FORCE TO 38G1-95-4**  
**MARINE CORPS TM 2815-24P/2**

(1)	(2)		(3)	(4)	(5)	(6)	(7)
ITEM	a.	SMR CODE	d.	PART	DESCRIPTION AND	QTY	USMC
NO.	ARMY	AIR FORCE	NAVY	FSCM	USABLE ON CODE (UOC)	QTY	QTY PER EQUIP
125	XDHZZ	XA		XBHZZ 78514	11099	..PLUNGER ROTOR OVERSIZE .350 CODE C.	2 2
125	XDHZZ	XA		XBHZZ 78514	11100	..PLUNGER ROTOR OVERSIZE .350 CODE D.	2 2
126	PBHZZ	PBOZZ		PBHZZ 84760	11438	.. SETSCREW	1 1
127	PBHZZ	PBOZZ		PBHZZ 84760	12216	.. SETSCREW	1 1
128	PAHZZ	PAOZZ		PAHZZ 84760	20727	.. CONNECTOR, FUEL LINE	3 4
129	PBHZZ	PBOZZ		PBHZZ 84760	24373	O-RING, PART OF KIT P/N 24373	1 1
130	PAHZZ	PAOZZ		PAHZZ 84760	29710	. SCREW, MACHINE	1 1
131	PBHZZ	PBOZZ		PBHZZ 78514	29384	. PLATE, RETAINING, BEA	1 1
132	XDHZZ	XA		XBHZZ 78514	13821	. VALVE, DELIVERY	1 1
132	XDHZZ	XA		XBHZZ 78514	13822	. VALVE, DELIVERY OVERSIZE	1 1
133	XDHZZ	XA		XBHZZ 78514	13837	. SCREW	1 1
134	XDHZZ	XA		XBHZZ 78514	10443	. RING, RETAINING	1 1
135	XDHZZ	XA		XBHZZ 78514	24691	. WASHER, SPRING	1 1
136	XDHZZ	XA		XBHZZ 78514	21521	. WASHER, THRUST	1 1
137	PAHZZ	PAOZZ		PAHZZ 78514	21618	. INSULATOR, TERMINAL	1 1
138	PAHZZ	PAOZZ		PAHZZ 78514	22985	. TERMINAL, BLADE	1 1
139	PAHZZ	PAOZZ		PAHZZ 78514	30789	. CAP	1 1
140	PAHZZ	PAOZZ		PAHZZ 78514	30788	. CUP	1 1
	PAHZZ	PAOZZ		PAHZZ 84760	24373	. GASKET KIT	1 1
					O-RING (1)	18-3	
					GASKET (1)	18-8	
					WASHER, TH (2)	18-26	
					SEAL, RING (3)	18-27	
					O-RING (2)	18-40	
					SEAL (1)	18-42	
					RETAINER (1)	18-46	
					O-RING (2)	18-49	
					PACKING, PREFORMED (2)	18-53	
					O-RING (2)	18-60	
					WASHER, SEAL (2)	18-66	
					STUD (2)	18-89	
					SEAL, DRIVE SHAFT (2)	18-95	
					O-RING (1)	18-103	
					O-RING (1)	18-11C	
					O-RING (11)	18-121	
					STOP VALVE (1)	18-123	
					O-RING (1)	18-129	

END OF FIGURE

**STANADYNE®****INJECTION PUMP SPECIFICATION ©**

FULL LOAD RPM: 1800  
GOV. REGULATION: 3-5 %  
ENGINE: 4039TF  
APPLICATION: 30 KW LIBBY GEN. SET  
DEPT. OF DEFENSE (1.2 CST MIN. FUEL)

CUSTOMER PART NO.: RE-40408  
CUSTOMER NAME & ADDRESS:  
JOHN DEERE DUBUQUE

MODEL NO.: DB2435-4806  
SUPERSEDES:  
EDITION NO.: 15  
DATED: 07-31-03

NOTE: THIS SPECIFICATION DEVELOPED WITH ISO LONG INLET STUD.  
ALL SPEEDS ARE IN ENGINE RPM UNLESS OTHERWISE NOTED.  
USE LATEST REVISION FOR ALL REFERENCED DOCUMENTS.

**TEST STAND: ISO 4008:**

1. CALIBRATING HIGH PRESSURE PIPES...SAE J1418/ISO 4093:  
.063" (1.6 mm) ID X 25" (635 mm) LONG.
2. CALIBRATING INJECTORS.....SAE J968/ISO 7440:  
0.5 mm ORIFICE PLATE NDP: 3000 PSI (207 BAR)
3. CALIBRATION FLUID: SAE J967/ISO 4113 (REF. S.B. 201)  
a. TEMPERATURE 110°-118°F (43°-48°C) AT INLET.  
b. SUPPLY PRESSURE (S.B. 334): 2.0 ± 0.5 PSI  
(14 ± 3 kPa) AT PUMP INLET.
4. CAM MOVEMENT READ-OUT DEVICE: #23745.

**PUMP INSTALLATION: IT-907**

ROTATION-C-  
NAME PLATE-L-SIDE\*\*  
#1 CYL.-5-O'CLOCK\*\*  
THROTTLE-L-SIDE\*\*  
TIMING MARK 131.5°  
E.S.O. (24V E.T.R.)

LEVER ANGLES (REF.)  
THOT MIN.(ZB) N/A  
THOT MAX.(ZC) N/A  
S.O.(Z E) N/A  
S.O.(Z F) N/A

\* VIEWED FROM DRIVE END \*\* VIEWED FROM TRANSFER PUMP END

PUMP OPERATING SPEED...HALF...ENGINE SPEED  
AIR TIME TO HOUSING FLANGE (SEE SPECIAL NOTES)  
MECHANICALLY TIMED TO CAM (S.B. 177)

**PUMP CALIBRATION CHECKS: AS RECEIVED FOR SERVICE**

1. 1000 RPM (WOT): OPERATE PUMP FOR 10 MINUTES TO BRING TO OPERATING TEMPERATURE AND CLEAR AIR FROM SYSTEM.
2. TURN SPEED DROOP TO MINIMUM POSITION (C/C DIRECTION).
3. 2100 RPM: PRIOR TO CHECKING PUMP PERFORMANCE, RESET HIGH IDLE SCREW TO OBTAIN 5 MAX mm<sup>3</sup>/STROKE.
4. CHECK POINTS:

RPM	THROTTLE POSITION	mm <sup>3</sup> /STROKE	ADVANCE
a. 150	WOT	38 MIN.	---
b. 400	WOT*	4 MAX.	---
c. 525	WOT	---	1.0°-3.0°
d. 1300	WOT	---	4.0°-5.0°
e. 1800	WOT	99-103	---
f. 1800	WOT*	4 MAX.	---
g. 2100	WOT	5 MAX.	---

\* E.S.O. DE-ENERGIZED

**PUMP SETTINGS: FOLLOWING PUMP SERVICE**

1. ROLLER-TO-ROLLER DIMENSION: 1.8805" ± .001"  
(50.30 mm ± .025 mm)  
MAXIMUM ECCENTRICITY: .004" (0.10 mm) T.I.R.
2. GOVERNOR LINKAGE GAP: .125" TO .165" (3.2-4.2 mm)  
(USE KIT #23093 S.B. 95).
3. 1000 RPM (WOT): OPERATE PUMP FOR 10 MINUTES TO BRING TO OPERATING TEMPERATURE AND CLEAR AIR FROM SYSTEM.
4. 400 RPM (WOT):  
a. CHECK SHUT-OFF: 4 mm<sup>3</sup>/STROKE, MAX.  
b. CHECK FOR MINIMUM TRANSFER PUMP LIFT OF 18" HG.  
(60 kPa)
5. 1800 RPM (WOT):  
a. SET TRANSFER PUMP PRESSURE FOR 78-80 PSI.  
(538-552 kPa)(SUPPLY SET PER TEST STAND NOTE 3B)  
b. ADJUST RETURN OIL TO 225-475 CC/MIN. RECHECK TRANSFER PUMP PRESSURE.  
c. CHECK HOUSING PRESSURE FOR 4-6.5 PSI. (28-59 kPa).
6. 525 RPM (WOT): SET ADVANCE TRIMMER SCREW FOR 2.0°.
7. 1800 RPM (WOT): SET ROLLER-TO-ROLLER FUEL DELIVERY: 100.5-101.5 mm<sup>3</sup>/STROKE.
8. TURN SPEED DROOP ADJUSTING CAP IN 2 FULL TURNS CLOCKWISE.
9. 2100 RPM (WOT): ADJUST HIGH IDLE SCREW TO OBTAIN 5 MAX mm<sup>3</sup>/STROKE.
10. CHECK POINTS:

RPM	THROTTLE POSITION	mm <sup>3</sup> /STROKE	ADVANCE	T.P. PRESSURE
a. 150	WOT	40 MIN.	---	**10 MIN.
b. 400	WOT*	4 MAX.	---	---
c. 525	WOT	---	1.0°-3.0°	---
d. 1300	WOT	---	4.0°-5.0°	---
e. 1800	WOT	100.5-101.5	---	***78-80
f. 1800	WOT*	4 MAX.	---	---
g. 2100	WOT	5 MAX.	---	---

\* E.S.O. DE-ENERGIZED \*\* (69 kPa) \*\*\* (538-552 kPa)

**11. SPECIAL NOTES:**

- TORQUE ALL FASTENERS PER S.B. 108.
- ASSEMBLE THROTTLE LEVER SPACER AND ARM IN B4-L POSITION PER S.B. 184.
- ASSEMBLE SHUT-OFF ARM IN L1-L POSITION PER S.B. 184.
- CHECK ELECTRIC SHUT-OFF PER S.B. 108.
- ADJUST SPEED DROOP PER S.B. 97R.
- SEAL FASTENERS PER S.B. 134.

**12. FOR SERVICE ONLY:**

AIR TIME PUMP USING HARTRIDGE BASIC AIR TIMING TOOL 7244-27 WITH INSERT 7244-30 AND PILOT RING 7244-28E. CONNECT AIR SUPPLY WITH 80-100 PSI (4.1-6.9 BAR) TO #1 CYLINDER OUTLET. SET TOOL TO 221° AND INSTALL TO DRIVE SHAFT. SLOWLY ROTATE TOOL CLOCKWISE UNTIL ROLLERS STRIKE CAM RING AND TOOL STOPS. SCRIBE LINE ON HOUSING FLANGE. REPEAT PROCEDURE TO ENSURE ACCURACY. IF INTERFERENCE BETWEEN STRAIGHT EDGE AND HOUSING FLANGE OCCURS, PLACE WASHER (I.e. 13521) BETWEEN STRAIGHT EDGE AND TOOL.

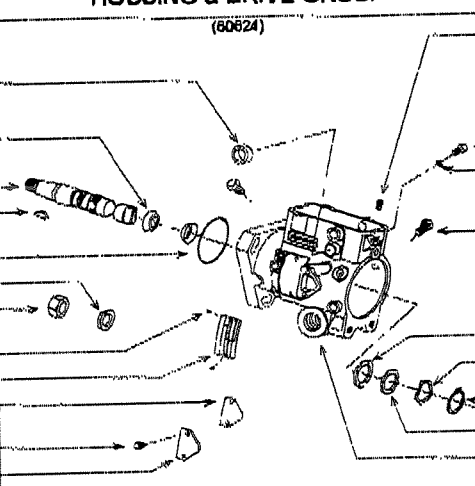
*Rodney G.*

DB2435-4806

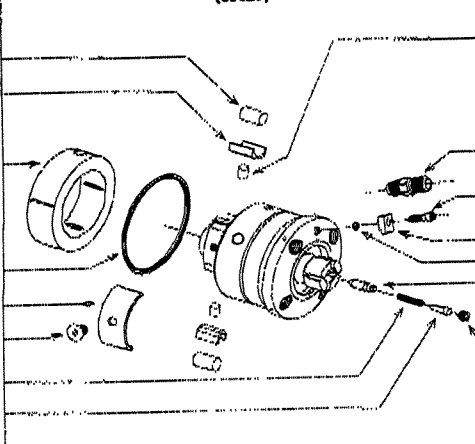
EDITION 15

DATED 07/31/2003

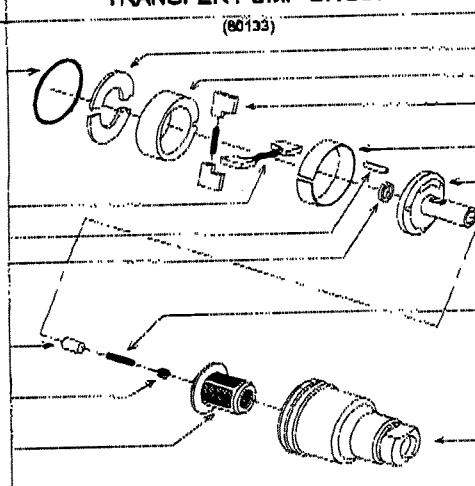
PAGE 2 OF 4

DESCRIPTION	QTY	P/N	HOUSING & DRIVE GROUP	P/N	QTY	DESCRIPTION
			(80624)			
SLEEVE, THROTTLE STOP	1	24364		21680	1	SCREW ASSY, VENT OR 21681-21685
SEAL, DRIVESHAFT	2	10453		10484	1	WASHER, SEALING
DRIVESHAFT	1	27639		12259	1	SCREW, PAN HEAD
KEY, WOODRUFF	1	30367		11331	2	SCREW, HEX HEAD
SEAL, O-RING	1	23367				
WASHER, DRIVESHAFT	1	32787				
NUT, HEX	1	26346				
SCREW, RIVET	2	24418		28180	1	BEARING, THRUST
NAMEPLATE	1	10394		24891	1	WASHER, DRIFT SPRING
GASKET, TIMING WINDOW CVR	1	27603		10443	1	RING, RETAINING
SCREW, HEX HEAD	2	21184		21521	1	WASHER, THRUST
COVER, TIMING WINDOW	1	23107		33057	1	HOUSING ASSY, PUMP

NOTES:

DESCRIPTION	QTY	P/N	HEAD & ROTOR GROUP	P/N	QTY	DESCRIPTION
			(80625)			
ROLLER, CAM	2	11141		32100	1	H&R ASSY, HYD 4 CYL
SHOE, CAM ROLLER	2	24569		11088	2	PLUNGER, ROTOR USE 11087-11090 (STD) OR 11087-11100 (O/S) AS IND. ON ROTOR SB 60R
RING, CAM	1	21687		11438	1	SCREW, SET
SEAL, O-RING	1	27245		12216	1	SCREW, HEAD PLUG
SPRING, LEAF	1	23752		20727	4	CONNECTOR, FUEL LINE
SCREW, LEAF SPR ADJ	1	11175		28710	1	SCREW, SKT HEAD CAP
SPRING, DLVY VALVE	1	16441		28384	1	PLATE, SINTERED LOCK
STOP, DELIVERY VALVE	1	16440		27601	1	SEAL, O-RING
				13821	1	VALVE, DELIVERY OR 13822 (O/S) AS REQ'D REF. S.B. 143B
				13837	1	SCREW, DLVY VALVE RET

NOTES:

DESCRIPTION	QTY	P/N	TRANSFER PUMP GROUP	P/N	QTY	DESCRIPTION
			(80133)			
SEAL, TRANSFER PUMP	1	27608		20530	2	RETAINER, ROTOR
				22988	1	LINER, TRANSFER PUMP
				20803	4	BLADE, TRANSFER PUMP OR 20804 REF. S.B. 304
				20528	1	RING, ROTOR RETAINER
				28987	1	REGULATOR ASSY, TP
SPRING, TP BLADE	2	15899				
ROLL PIN	1	19837		19855	1	SPRING, REGULATING
SEAL, TP RGLTR SLEEVE	1	19844				
PISTON, REGULATING	1	19895				
PLUG ASSY, END PL ADJ	1	16228		28980	1	CAP, TP END
FILTER, INLET	1	28986				

NOTES:

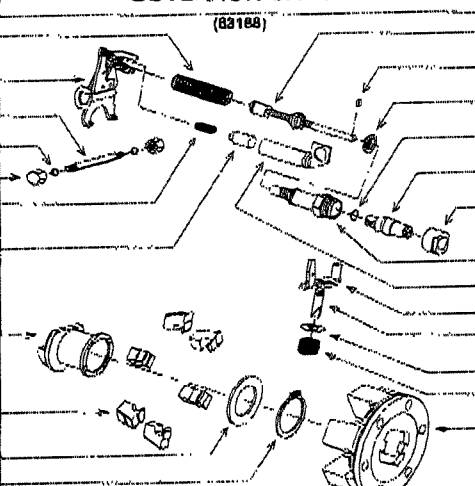
INDENTED ITEMS INCLUDED

DB2435-4806

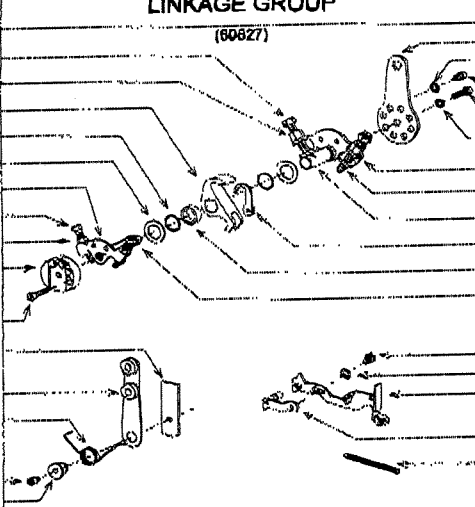
EDITION 15

DATED 07/31/2003

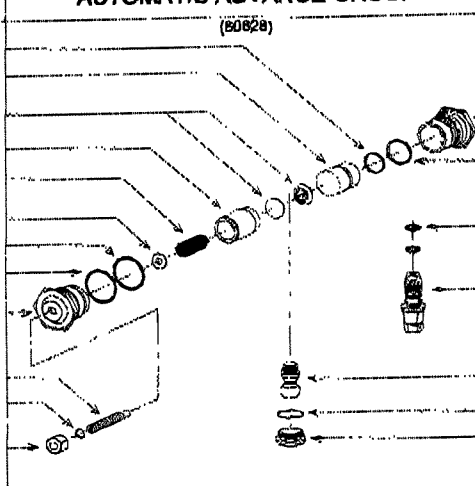
PAGE 3 OF 4

DESCRIPTION	QTY	P/N	GOVERNOR GROUP	P/N	QTY	DESCRIPTION
SPRING, SPEED DROOP RED STRIPE	1	13568		20240	1	ROD ASSY-CONTROL
ARM ASSY, GOVERNOR	1	20218		13554	1	PIN, CONTROL SPRING
SHAFT, GOVERNOR ARM	1	20224		27806	1	WASHER, SEALING
SEAL, O-RING	2	31332		12968	1	SEAL, O-RING
NUT, PIVOT SFT RTNR	2	12288		36556	1	CAP, ADJUSTING
SPRING, DAMPER	1	20475		20355	1	CAP, DROOP CTRL LOCK
PISTON ASSY, DAMPER	1	18572		27588	1	GUIDE, CONTROL ROD
				18588	1	BARREL ASSY, DAMPER
SLEEVE, GOV THRUST	1	14483		22134	1	ARM ASSY, MTR VALVE
				11563	1	VALVE, METERING * SEE NOTE
WEIGHT, GOV PLATED	6	20214		26427	1	SHIM, MTR VALVE SPRG
WASHER, THRUST	1	20222		20358	1	SPRING, MTR VALVE
RING, RETAINING	1	12285		28881	1	RETAINER ASSY, GOV WT

NOTES: \* O.S. METERING VALVE AND ARM ASSEMBLY 22248 REFERENCE S.B.336

DESCRIPTION	QTY	P/N	LINKAGE GROUP	P/N	QTY	DESCRIPTION
SCREW, HEX HEAD	1	12972		12985	1	LEVER, THROTTLE ADJ
NUT, HEX	1	12174		12049	1	WASHER, INTL TOOTH
LEVER, THROTTLE FORK	1	12221		12051	1	SCREW, SOCKET CAP
SEAL, O-RING	2	17438		12998	1	SCREW, SKT HEAD CAP
WASHER, SPACER	2	14408		11682	1	WASHER, INTL TOOTH
SHAFT ASSY, THROTTLE	1	12019		12174	1	NUT, HEX
SCREW, HEX HEAD	1	12167		12972	1	SCREW, HEX HEAD
NUT, HEX	2	12174		18247	1	SHAFT ASSY, SHUTOFF
SPACER, THROT LVR ADJ	1	16135		14966	1	CAM ASSY, SHUTOFF
				16587	1	SPACER, THROT SHAFT
SCREW, SOCKET CAP	1	12051		12188	1	SCREW, HEX HEAD
ARM, ADJUSTING SPACER	1	18136		30418	1	HOOK ASSY, GOV LKGE
LEVER ASSY, THROTTLE	1	16392		12360	1	SCREW, HEX HEAD
SPRING, THROT LEVER	1	13003		12362	1	LOCK WASHER, SHPRF
				30419	1	HOOK, GOV LINKAGE
SCREW, SKT HEAD CAP	1	15888		20225	1	LINK ASSY, HOOK ADJ
RNTR, THROT LVR SPR	1	13010		11919	1	SPRING, GOVERNOR LINK

NOTES: THROTTLE LEVER BUSHING OUT

DESCRIPTION	QTY	P/N	AUTOMATIC ADVANCE GROUP	P/N	QTY	DESCRIPTION
SEAL, RECT SECTION	1	29281				
PISTON, POWER	1	22858				
WASHER, ADVANCE SLIDE	2	12622		22858	1	PLUG, PISTON HOLE
PISTON, SPRING	1	27907		18987	1	RING, PISTON SEAL
5 DEG. RETARD	1	18958		27802	2	SEAL, O-RING
SPRING, ADVANCE	1	14940		22238	1	SCREW, HEAD LOCATING 0.02
BLACK-BROWN				33627	1	SCREW, CAM ADVANCE
GUIDE, ADV ADJ SPRING	1	29280		27810	1	SEAL, O-RING
SEAL, O-RING	2	29282		23058	1	PLUG, HEX SOCKET
SEAL, O-RING	2					
PLUG, PISTON HOLE	1	14941				
SCREW, ADV ADJUSTING	1	14544				
SEAL, O-RING	1	17438				
NUT, HEX LOCK	1	13807				

NOTES: ASSEMBLE 22858 PISTON WITH PART NUMBER TOWARDS PISTON HOLE PLUG

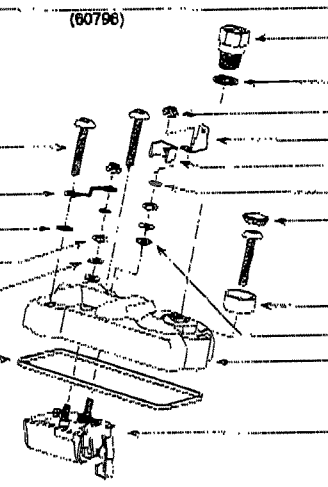
INDENTED ITEMS INCLUDED

DB2435-4806

EDITION 15

DATED 07/31/2003

PAGE 4 OF 4

DESCRIPTION	QTY	P/N	COVER GROUP	P/N	QTY	DESCRIPTION
			(60796)			
SCREW, BUTTON HD CAP	3	22351		21251	1	RLTR ASSY, HSG PRESS
STRAP, TERM GROUNDING	1	20951		27607	1	SEAL, O-RING
WASHER, INTL TOOTH	1	18483		14760	2	NUT, HEX LOCK
NUT, HEX	2	12519		22985	1	TERMINAL, BLADE
WASHER, PLAIN	2	18501		21818	1	INSULATOR, TERMINAL
SEAL, RECT SECTION	1	27244		12049	2	WASHER, INTL TOOTH
				30799	1	CAP, COVER SCREW
				30788	1	CUP, COVER SCREW
				12500	2	WASHER, FIBER
				21898	1	COVER, GOV CONTROL
				26387	1	SOLENOID, 24V ETR 2-23190 TUBE, INSULATE

NOTES: INSTALL GROUNDING STRAP ON LEFT SIDE VIEWING TRANSFER PUMP REFERENCE S.B. 108

FOR SERVICE USE ONLY  
APPLICABLE SERVICE ASSEMBLIES

THROTTLE SHAFT BUSHING REPLACEMENT	17778
PILOT TUBE REPLACEMENT (REF SB 171C)	32980
OVERHAUL GASKET KIT	33814
ESO MOUNTING AND GROUNDING KIT	28431

FOR ENGINEERING USE ONLY  
DATE CHANGE NO. EDITION

06/30/1988	19808	1
08/24/1988	19883	2
09/22/1989	19739	3
03/05/1991	20412	4
05/08/1991	20749	5
07/25/1991	20820	6
03/11/1992	21048	7
03/11/1992	21387	7
05/13/1992	21587	8
12/22/1992	22027	9
09/03/1993	22727	10
01/28/1996	22727	11
12/06/1999	28615M	12
02/07/2000	26684	13
11/18/2001	27585	14
07/31/2003	27583	15

INDENTED ITEMS INCLUDED

**STANADYNE ROTARY PUMP**

**60KW GENERATOR SET**

ARMY TECHNICAL MANUAL  
AIR FORCE TECHNICAL ORDER  
NAVY PUBLICATION  
MARINE CORPS STOCK LIST

\*TM 9-6115-465-24P  
TO-35C2-3-446-4  
NAVFAC P-8-625-24P  
SL-4-06858B/06859D

---

TECHNICAL MANUAL

UNIT, DIRECT SUPPORT, AND  
GENERAL SUPPORT MAINTENANCE REPAIR PARTS AND  
SPECIAL TOOLS LISTS (INCLUDING DEPOT MAINTENANCE  
REPAIR PARTS AND SPECIAL TOOLS)

GENERATOR SET, DIESEL ENGINE DRIVEN, TACTICAL SKID MTD. 30 KW,  
3 PHASE, 4 WIRE, 120/208 AND 240/416 VOLTS

<u>DOD MODEL</u>	<u>CLASS</u>	<u>HERTZ</u>	<u>NSN</u>
MEP-005A	UTILITY	50/60	6115-00-118-1240
MEP-104A	PRECISE	50/60	6115-00-118-1247
MEP-114A	PRECISE	400	6115-00-118-1248

INCLUDING OPTIONAL KITS

<u>DOD MODEL</u>	<u>NOMENCLATURE</u>	<u>NSN</u>
MEP-005-AWF	WINTERIZATION KIT, FUEL BURNING	6115-00-63-9083
MEP-005-AWE	WINTERIZATION KIT, ELECTRIC	6115-00-463-9085
MEP-002-ALM	LOAD BANK KIT	6115-00463-9088
MEP-005-AWM	WHEEL MOUNTING KIT	6115-00-463-9094

Approved for public release; distribution is unlimited.

\*This manual supersedes TM 5-6115-465-24P/TO 35C2-3-446-4 / NAVFAC P-8-625-24P / SL-4-06858B/06859D, dated 15 January 1982, including all changes.

---

HEADQUARTERS, DEPARTMENTS OF THE ARMY, AIR FORCE, NAVY  
AND HEADQUARTERS U.S. MARINE CORPS

3 JUNE 1992



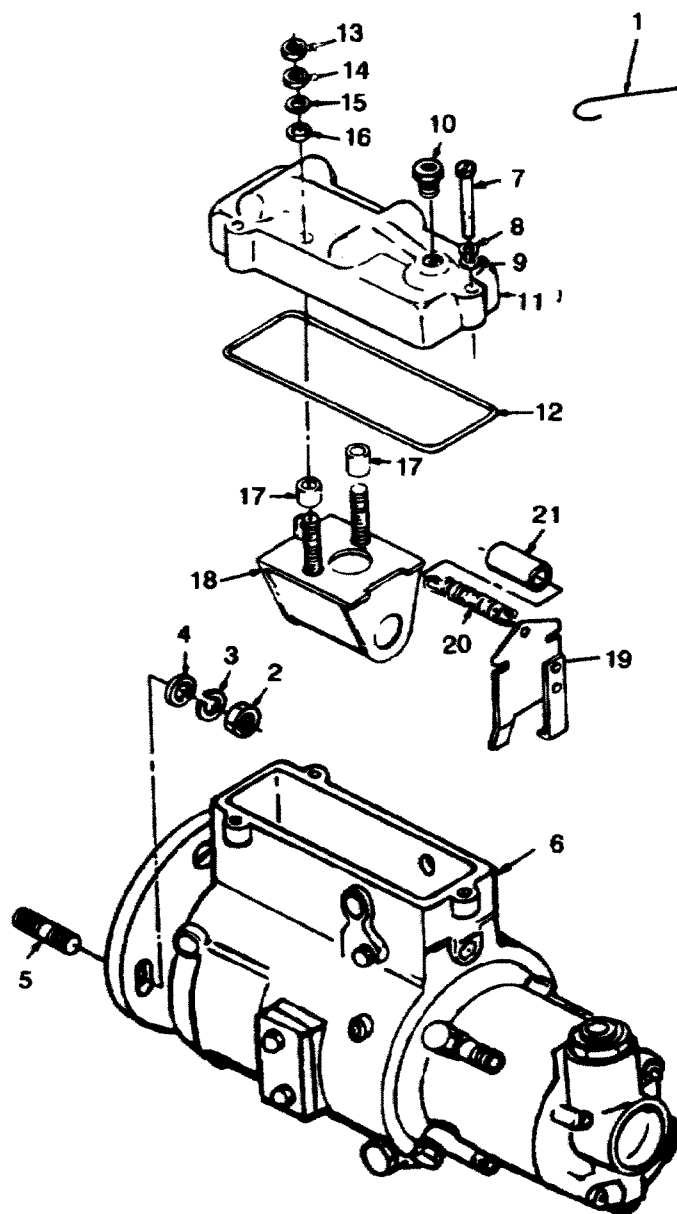


Figure 67. Fuel injection pump governor.

TM9-6115-465-24P  
TO 35CZ-3-446-4  
NAVPAC P-8-628-24P  
SL-4-06858B/06859D

(1) ILLUSTRATION		(2) SNR CODE		(3)		(4) NATIONAL STOCK NUMBER		(5) DESCRIPTION		(6) USABLE ON CODE		(7) QTY INC IN UNITS		(8) USMC QTY PER EQUIP	
A	B	A	B	C	D	A	B	REP NUMBER & RWP CODE							
FIG. NO.	ITEM NO.	ARMY	AIR FORCE	NAVY	USMC	SSI	REPL FACTOR								
67	1	XBPEZ	NEO	XROZZ	XBPEZ			WREN, LOCKOUT: GOVERNOR 72-2164 30554 30554-72-2164 36024				PT	2		V
67	2	PAPEZ	PACZZ	PAGZZ	PAPEZ	D	.008	5310-00-732-0559	NUT, PLAIN, HEXAGON: PUMP MTG MS1968-8 96906			EA	2		
67	3	PAPEZ	PACZZ	PAGZZ	PAPEZ	D	.010	5310-00-209-0920	WASHER, LOCK: PUMP MTG 342A 28265			EA	2		
67	4	PAPEZ	PACZZ	PAGZZ	PAPEZ	D	.010	5310-00-209-3671	WASHER, PLAIN: PUMP MTG 2W1-24-24-92 43999			EA	2		2
67	5	XBPEZ	XBQZZ	XBHZZ				STUD, PLAIN: PUMP MTG 6957A 28265				EA	2		2
67	6	PAPEZ	PACZZ	PAHHH	PAPEZ		.700	2910-00-499-0818	PUMP, FUEL: INJECTION DBMPC33-1LK 84760			EA	1		1
67	7	PAPEZ	PACZZ	PAGZZ	PAPEZ	D	.008	5305-00-846-0129	SCREW, MACHINE: COVER MTG MS35265-68 96906			EA	3		3
67	8	PAPEZ	PACZZ	PAGZZ	PAPEZ	D	.010	5310-00-796-8638	WASHER, LOCK: COVER MTG 11582 87460			EA	3		8
67	9	PAPEZ	PACZZ	PAGZZ	PAPEZ	D	.010	5310-00-194-0607	WASHER, PLAT: COVER MTG S8153-6-031C 70210			EA	3		7
67	10	PAPEZ	PACZZ	PAGZZ	PAPEZ	D	.008	4730-00-200-3412	CONNECTOR ASSEMBLY 20154 84760			EA	1		1
67	11	XBPEZ	PACZZ	KBQZZ	PAPEZ			2910-00-335-9329	COVER, CONTROL 1210G 87460			EA	1		1
67	12	KPEZZ	PACZZ	KPGZZ	KPEZZ			5330-00-640-9399	CASKET: COVER (PART OF KIT, NSN 5330-00-401-5247) 12054 87460			EA	1		1
67	13	PAPEZ	PACZZ	PAGZZ	PAPEZ	D	.068	5310-00-807-1466	NUT, LOCK: TERMINAL MS21042-08 96906			EA	2		2
67	14	PAPEZ	PACZZ	PAGZZ	PAPEZ	D	.008	5310-00-934-9757	NUT, TERMINAL MS35649-282 96906			EA	2		2
67	15	PAPEZ	PACZZ	PAGZZ	PAPEZ	D	.010	5310-00-461-8858	WASHER, CONTACT 18501 87460			EA	2		2
67	16	PAPEZ	PACZZ	PAGZZ	PAPEZ	D	.010	5310-00-830-7825	WASHER, INSULATING 12500 87460			EA	2		2
67	17	PAPEZ	PACZZ	PAGZZ	PAPEZ	D	.023	5330-00-786-4025	TUBE, INSULATING 12513 87460			EA	2		2
67	18	XBPEZ	PACZZ	KBQZZ	PAPEZ			2910-00-897-2459	FRAME ASSEMBLY 16355 87460			EA	1		1
67	19	XBPEZ	PACZZ	KBQZZ	PAPEZ			2910-00-832-0122	ARM ASSEMBLY 16278 87460			EA	1		1
67	20	PAPEZ	PACZZ	PAGZZ	PAPEZ	D	.035	5360-00-691-7207	SPRING, ARM 12480 87460			EA	1		1
67	21	XBPEZ	PACZZ	PAGZZ	PAPEZ			5365-00-209-3149	SLEWVE 16396 87460			EA	1		1

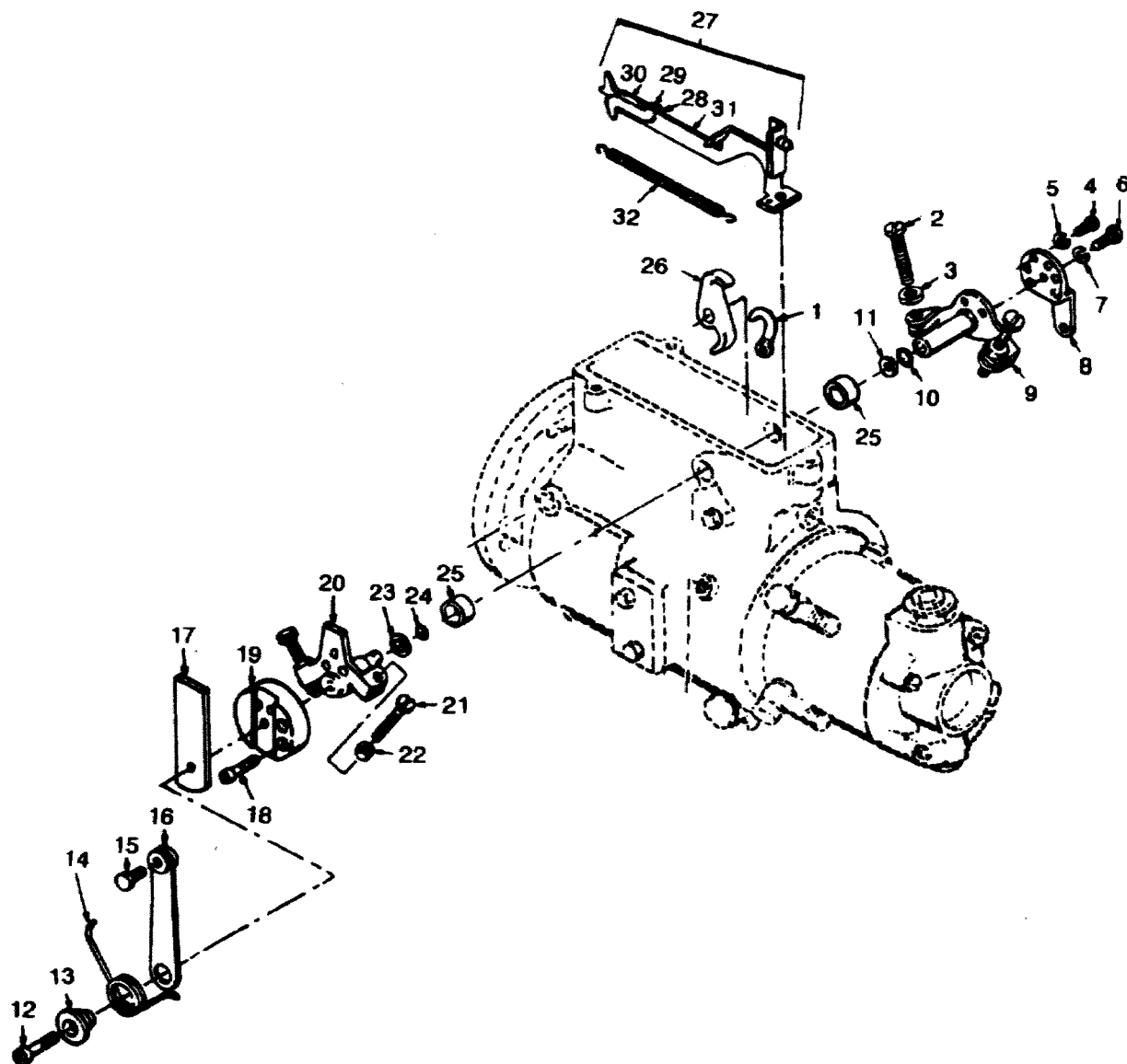


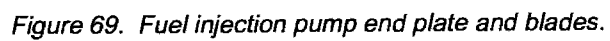
Figure 68. Fuel injection pump linkage and control.

TM9-6115-465-24P  
TO 35C2-3-446-4  
NAVJAG P-8-625-24P  
SL-4-068588/068590

(1) ILLUSTRATION		(2) SNR CODE		(3)			(4) NATIONAL STOCK NUMBER		(5) DESCRIPTION		(6) USABLE CN CODE		(7) QTY IN UNITS	(8) USMC QTY PER EQUIP
A FIG. NO.	B ITEM NO.	A ARMY	B AIR FORCE	C NAVY	D USMC	A SSI	B REPL FACTOR	REF NUMBER & NFR CODE		U/M				
68	1	PAPZZ	PACZZ	PAGZZ	PAHZZ		.009	2910-00-066-2499 CAM ASSEMBLY 14966 87460		EA	1	1		
68	2	PAPZZ	PACZZ	PAGZZ	PAHZZ	D	.008	5305-00-891-8979 SCREW, MACHINE: ADJUSTING 12972 87460		EA	2	4		
68	3	PAPZZ	PACZZ	PAGZZ	PAHZZ	D	.008	5310-00-934-9751 NUT, PLAIN, HEXAGON: ADJUSTING SCREW MS35650-32 96906		EA	1	3		
68	4	PAPZZ	PACZZ	PAGZZ	PAHZZ	D	.008	5305-00-978-9368 SCREW, MACHINE: LEVER MTG MS16997-30 96906		EA	1	2		
68	5	PAPZZ	PACZZ	PAGZZ	PAHZZ	D	.010	5310-00-559-0070 WASHER, LOCK: ADJUSTING LEVER MS35333-38 96906		EA	1	1		
68	6	PAPZZ	PACZZ	XBGZZ	PAHZZ	D	.008	5305-01-007-1321 SCREW, MACHINE: ADJUSTING 12998 87460		EA	1	1		
68	7	PAPZZ	PACZZ	XBGZZ	PAHZZ	D	.010	5310-00-796-8638 WASHER, LOCK: ADJUSTING SCREW 11582 87460		EA	1	8		
68	8	XBPZZ	PACZZ	PAGZZ	PAHZZ			2910-00-335-9301 LEVER, ADJUSTING 12979 87460		EA	1	1		
68	9	PAPZZ	PACZZ	PAGZZ	PAHZZ		.021	2910-00-897-2545 SHAFT ASSEMBLY, LEVER 12237 87460		EA	1	1		
68	10	KPFZZ	PACZZ	KPGZZ	KPEZZ			5330-00-641-8282 SEAL, SHAFT (PART OF KIT, NSN 5330-00-401-5247) 12040 87460		EA	1	2		
68	11	KPFZZ	PACZZ	KPGZZ	KPFZZ			5310-00-877-4956 WASHER, PLAT: SEAL RETAINER (PART OF KIT, NSN 5330-00-401-5247) 14408 87460		EA	1	2		
68	12	PAPZZ	PACZZ	PAGZZ	PAHZZ	D	.008	5305-00-638-8859 SCREW, SPRING 887047PCL3 10001		EA	1	1		
68	13	PAPZZ	PAPZZ	PAGZZ	PAHZZ	D	.013	5340-00-786-1550 RETAINER, SPRING 13010 87460		EA	1	1		
68	14	PAPZZ	PACZZ	PAGZZ	PAHZZ		.047	5360-00-751-8916 SPRING, LEVER 13003 87460		EA	1	1		
68	15	PAPZZ	PACZZ	PAGZZ	PAHZZ	D	.008	5305-00-788-3735 SCREW, CAP, HEXAGON HEAD: LEVER 12957 87460		EA	1	1		
68	16	XBPZZ	PACZZ	PAGZZ	PAHZZ			2910-00-204-9550 LEVER ASSEMBLY 12949 87460		EA	1	1		
68	17	XBPZZ	PACZZ	PAGZZ	PAHZZ			2910-00-127-5075 ARM 16136 97460		EA	1	1		
68	18	PAPZZ	PACZZ	PAGZZ	PAHZZ	D	.008	5305-00-978-9368 SCREW, MACHINE: SPACER MTG MS16997-30 96906		EA	1	2		
68	19	XAPZZ	PACZZ	PAGZZ	PAGZZ			5340-00-125-6003 SPACER 16136 87460		EA	1	1		
68	20	PAPZZ	PACZZ	PAGZZ	PAHZZ		.020	2910-00-204-9549 SHAFT ASSEMBLY 17619 87460		EA	1	1		
68	21	PAPZZ	PACZZ	PAGZZ	PAHZZ	D	.008	5305-00-891-8979 SCREW, MACHINE: ADJUSTING 12972 87460		EA	2	2		
68	22	PAPZZ	PACZZ	PAGZZ	PAHZZ	D	.008	5310-00-934-9751 NUT, PLAIN, HEXAGON MS35650-302 96906		EA	2	3		

TM9-6115-465-24P  
 TO 35C2-3-446-4  
 NAVJRC P-8-625-24P  
 SU-4-068588/068590

(1)		(2)		(3)		(4)		(5)		(6)		(7)	(8)
ILLUSTRATION		SMR CODE				NATIONAL STOCK NUMBER		DESCRIPTION		USABLE ON		QTY INC IN UNITS	USMC QTY PER EQUIP
A	B	A	B	C	D	A	B	REP NUMBER & MFR CODE	U/M				
FIG. NO.	ITEM NO.	ARMY	AIR FORCE	NAVY	USMC	SSI	REPL FACTOR						
68	23	PHFZZ	PAGZZ	PAGZZ	KPHZZ		.046	5330-00-641-8282 SEAL, SHAFT 12040 87460	EA		1	2	
68	24	PAFZZ	PAGZZ	PAGZZ	KPHZZ	D	.010	5310-00-877-4956 WASHER, PLAT: SEAL RETAINER 14408 87460	EA		1	2	
68	25	XBPFZ	XCO	XBGZZ	XBHEZ			SPACER, SHAFT 16587 87460	EA		2	2	
68	26	XBPFZ	PAGZZ	PAGZZ	PAHZZ			2910-00-788-0989 LEVER, SHAFT 12221 87460	EA		1	1	
68	27	PAFZZ	PAGZZ	XBCZZ	PAHZZ		.020	2910-00-148-6557 HOOK ASSEMBLY 20226 87460	EA		1	1	
68	28	PAFZZ	PAGZZ	PAGZZ	PAHZZ	D	.008	5305-00-250-5613 SCREW, MACHINE: HOOK 12360 87460	EA		1	1	
68	29	XAFZZ	PAGZZ	PAGZZ	PAHZZ	D	.010	5310-00-410-8585 WASHER, LOCK: HOOK 12362 87462	EA		1	1	
68	30	XAFZZ	PAGZZ	XA	XAHZZ			LINK ASSEMBLY 20225 87460	EA		1	1	
68	31	XAFZZ	PAGZZ	XBGZZ	XAHZZ			HOOK, LINKAGE 17604 87460	EA		1	1	
68	32	PAFZZ	PAGZZ	PAGZZ	PAHZZ		.035	5360-00-335-9237 SPRING 11919 87460	EA		1	1	



TM9-6115-465-24P  
TO 35C2-3-446-4  
NAVJAG P-8-625-24P  
SU-4-068588/068590

(1) ILLUSTRATION		(2) SMR CODE		(3)		(4) NATIONAL STOCK NUMBER		(5) DESCRIPTION		(6) USABLE ON CODE	(7) QTY IN UNITS	(8) USMC QTY PER EQUIP
A FIG. NO.	B ITEM NO.	A ARMY	B AIR FORCE	C NAVY	D USMC	A SSI	B REPL FACTOR	REP NUMBER & MPE CODE		U/M		
69	1	PAPZZ	PAOZZ	XBGZZ	PAHZZ	D	.005	4730-00-459-6077 PLUG, PIPE SLEEVE 15228 87460		EA	1	1
69	2	PAPZZ	PAOZZ	XBGZZ	PAHZZ	D	.008	2910-00-897-2460 SLEEVE, PLATE 17058 87460		EA	1	1
69	3	KPFZZ	PAOZZ	KPGZZ	KPHZZ			5330-00-171-5641 SEAL, END PLATE (PART OF KIT, NSN 5330-00-401-5247) 12406 87460		EA	1	1
69	4	PAPZZ	PAOZZ	PAGZZ	PAHZZ		.040	2910-00-898-4926 ELEMENT, FILTER 15225 87460		EA	1	1
69	5	KPFZZ	PAOZZ	KPGZZ	KPHZZ			2910-00-898-4927 SEAL, ELEMENT (PART OF KIT, NSN 5330-00-401-5247) 87460		EA	1	1
69	6	KPFZZ	PAOZZ	KPGZZ	KPHZZ			5330-00-641-8203 RING, SEAL (PART OF KIT, NSN 5330-00-401-5247) 11507 87460		EA	1	3
69	7	PAPZZ	PAOZZ	PAGZZ	PAHZZ		.015	5300-00-418-4365 SPRING, PISTON 15913 87460		EA	1	1
69	8	PAPZZ	PAOZZ	PAGZZ	PAHZZ	D	.007	2910-00-321-8737 PISTON 11508 87460		EA	1	1
69	9	PAPZZ	PAOZZ	KPGZZ	PAHZZ		.046	2910-00-901-0749 SEAL, PISTON 17056 87460		EA	1	1
69	10	XBPZZ	PAOZZ	XBGZZ	PAHZZ			5365-00-556-7446 PLUG, END PLATE 17451 87460		EA	1	1
69	11	KPFZZ	PAOZZ	PAGZZ	KPHZZ			5330-00-877-4960 SEAL, (PART OF KIT, NSN 5330-00-401-5247) 12966 87460		EA	1	2
69	12	PAPZZ	PAOZZ	PAGZZ	PAHZZ		.040	5310-00-934-9751 SEAL 204607A 87460		EA	1	1
69	13	PAPZZ	PAOZZ	PAGZZ	PAHZZ	D	.008	5305-00-786-4028 SCREW, MACHINE: END PLATE MTG 11532 87460		EA	4	4
69	14	PAPZZ	PAOZZ	PAGZZ	PAHZZ	D	.010	5310-00-796-8638 WASHER, LOCK: END PLATE MTG 11582 87460		EA	4	8
69	15	PAPZZ	PAOZZ	PAGZZ	PAHZZ	D	.010	5310-00-194-0607 WASHER, PLAT: END PLATE MTG S01153-6-031C 70210		EA	4	7
69	16	XBPZZ	PAOZZ	XBGZZ	PAHZZ	D	.008	2990-00-459-7135 PLATE, END 15877 87460		EA	1	1
69	17	XBPZZ	PAOZZ	XBGZZ	PAHZZ	D	.008	2910-00-901-0753 PLATE, TRUST 15875 87460		EA	1	1
69	18	PAPZZ	PAOZZ	PAGZZ	PAHZZ	D	.008	5315-00-992-7084 PIB, COLL TRUST PLATE 11525 87460		EA	1	1
69	19	KPFZZ	PAOZZ	KPGZZ	KPHZZ			5330-00-853-2976 SEAL, PUMP (PART OF KIT, NSN 5330-00-401-5247) 11329 87460		EA	1	1
69	20	PAPZZ	PAOZZ	XBGZZ	PAHZZ		.020	2910-00-148-6555 BLADE, PUMP 18657 87460		EA	4	4
69	21	PAPZZ	PAOZZ	PAGZZ	PAHZZ		.015	5360-00-900-2564 SPRING, BLADE 15699 87460		EA	2	2
69	22	XBPZZ	PAOZZ	XBGZZ	XPHZZ	D	.008	2910-00-208-6974 LINER, PUMP 18658 87460		EA	1	1

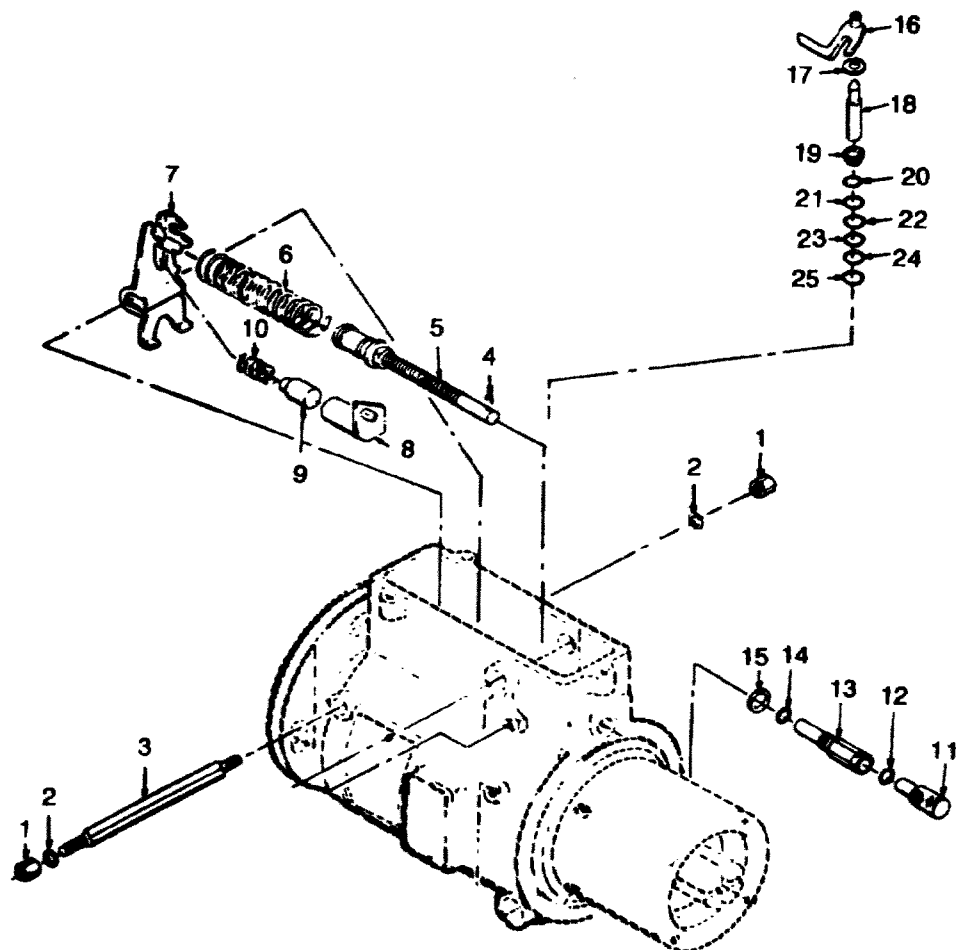


Figure 70. Fuel injection pump, pivot shaft and arm assembly.



TM9-6115-465-24P  
TO 35C2-3-446-4  
NAVJAG P-8-625-24P  
SU-4-068588/068590

(1) ILLUSTRATION A FIG. NO.	(2) SMR CODE B ITEM NO.	(3) A ARMY	(4) B AIR FORCE	(5) C NAVY	(6) D USMC	(7) E SSI	(8) F REPL FACTOR	(9) NATIONAL STOCK NUMBER	(10) DESCRIPTION REF NUMBER & MFR CODE	(11) UNABLE ON CODE	(12) U/M	(13) QTY TMC IN UNITS	(14) USMC QTY PER EQUIP
70	1	PAPZZ	PACZZ	PAGZZ	PAHZZ	D	.006	5310-00-791-9437	NUT, RETAINING 12288 87460		EA	2	2
70	2	KPFZZ	PAOZZ	KPGZZ	KPHZZ			5330-00-641-8288	SEAL, SHAFT (PART OF KIT, SNS 5330-00-401-5247) 11588 87460		EA	2	2
70	3	PAPZZ	PACZZ	XBGZZ	PAHZZ		.020	2910-00-148-6552	SHAFT, PIVOT 20224 87460		EA	1	1
70	4	PAPZZ	PACZZ	PAGZZ	PAHZZ	D	.015	5315-00-786-3998	PIN, SPRING 13554 87460		EA	1	1
70	5	KBPZZ	PAOZZ	XBGZZ	PAHZZ			2910-01-005-6242	ROD ASSEMBLY, CONTROL 18275 87460		EA	1	1
70	6	PAPZZ	PACZZ	PAGZZ	PAHZZ	D	.015	5360-00-786-1546	SPRING, CONTROL 13558 87460		EA	1	1
70	7	KBPZZ	PACZZ	XBGZZ	PAHZZ			2910-01-005-5108	ARM ASSEMBLY 20219 87460		EA	1	1
70	8	KBPZZ	PACZZ	PAGZZ	PAHZZ			2910-00-200-3294	BARREL ASSEMBLY 16568 87460		EA	1	1
70	9	KBPZZ	PACZZ	PAGZZ	PAHZZ			2910-00-780-0938	PISTON ASSEMBLY 16572 87460		EA	1	1
70	10	KBPZZ	PACZZ	PAGZZ	PAHZZ			5360-01-022-3146	SPRING, DAMPER 20475 87460		EA	1	1
70	11	KBPZZ	PACZZ	PAGZZ	PAPZZ			2910-00-786-1565	CAP ASSEMBLY, ADJUSTING 13567 87460		EA	1	1
70	12	PAPZZ	PAOZZ	KPGZZ	PAHZZ		.040	5330-00-877-4960	SEAL, CAP 12966 87460		EA	2	2
70	13	KBPZZ	PAOZZ	XBGZZ	PAHZZ			2910-00-383-5134	GUIDE, CONTROL ROD 20223 87460		EA	1	1
70	14	KBPZZ	PACZZ	PAGZZ	PAHZZ			5310-00-877-4957	WASHER, GUIDE 13672 87460		EA	1	1
70	15	KPHZZ	PACZZ	KPGZZ	KPHZZ			5330-00-937-8477	SEAL, GUIDE (PART OF KIT, SNS 5330-00-401-5247) 13558 87460		EA	1	1
70	16	KBPZZ	PACZZ	PAGZZ	PAHZZ			2910-00-897-2466	ARM ASSEMBLY, VALVE 14680 87460		EA	1	1
70	17	PAPZZ	PACZZ	PAGZZ	PAHZZ	D	.005	5310-00-877-4952	SEIM, VALVE 11610 87460		EA	1	1
70	18	PAPZZ	PACZZ	PAGZZ	PAHZZ		.020	2910-01-054-3816	VALVE METERING 20849 87460		EA	1	1
70	19	KBPZZ	PACZZ	XBGZZ	PAHZZ	D	.008	5365-00-485-0097	SPACER, VALVE 16573 87460		EA	1	1
70	20	KBPZZ	PACZZ	XBGZZ	KPHZZ				SEIM, VALVE 16576 87460		EA	V	V
70	21	KBPZZ	PACZZ	XBGZZ	KPHZZ				SEIM, VALVE 19579 87460		EA	V	V

TM9-6115-455-24P  
 TO 35C2-3-446-4  
 NAVPAC P-R-625-24P  
 NL-4-068588/06859D

(1) ILLUSTRATION		(2) SMR CODE		(3)		(4) NATIONAL STOCK NUMBER		(5) DESCRIPTION	(6) USABLE ON		(7) QTY INC IN UNITS	(8) QTY PER EQUIP
A FIG. NO.	B ITEM NO.	A ARMY	B AIR FORCE	C NAVY	D USMC	A SSI	B REPL FACTOR	REP NUMBER & MPR CODE	CH CODE	U/M		
70	22	XBGZZ	PACZZ	XBGZZ	XBRZZ			SHIM: VALVE 16580 87460		EA	V	V
70	23	XBPZZ	XB	XBGZZ	XBRZZ			SHIM: VALVE 16581 87460		EA	V	V
70	24	XBPZZ	XB	XBGZZ	XBRZZ			SHIM: VALVE 16582 87460		EA	V	V
70	25	XBPZZ	XB	XBGZZ	XBRZZ			SHIM: VALVE 16583 87460		EA	V	V

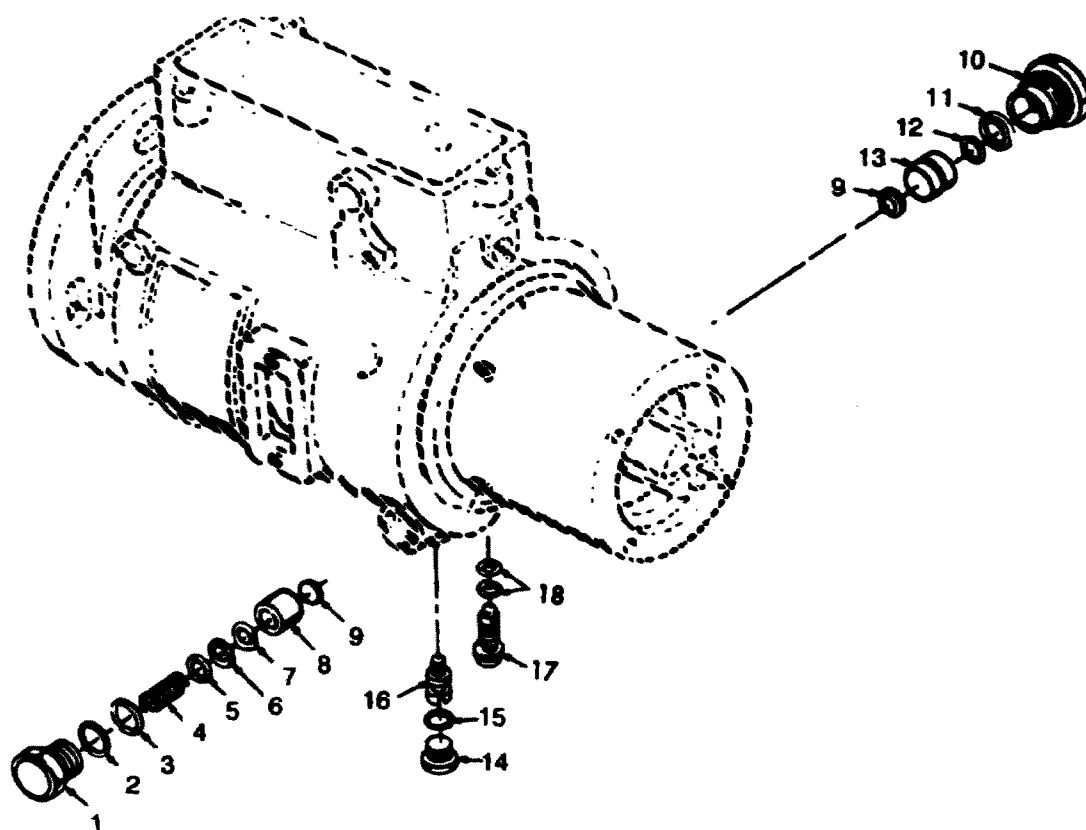


Figure 71. Fuel injection pump piston and damper spring.

TM9-6115-465-24P  
 TO 35C2-3-446-4  
 NAVPAC P-8-625-24P  
 SL-4-06858B/06859D

(1) ILLUSTRATION		(2) SMR CODE		(3)		(4) NATIONAL STOCK NUMBER		(5) DESCRIPTION		(6) USABLE ON		(7) QTY TNC IN UNITS	(8) USMC QTY PER EQUIP
A	B	A	B	C	D	A	B	REF NUMBER & MFR CODE		U/M			
FIG. NO.	ITEM NO.	ARMY	AIR FORCE	NAVY	USMC	SSI	REPL FACTOR						
71	1	XBZZ	XBO	XBGZZ	XBZZ			PLUG 12640 87460		EA		1	1
71	2	PAPZZ	PAOZZ	KPGZZ	PAZZ		.040	5330-01-014-6985 SEAL, PLUG 20113 87460		EA		2	2
71	3	PAPZZ	PAOZZ	KPGZZ	PAZZ		.040	5330-00-974-6643 SEAL, PLUG 12764 87460		EA		2	2
71	4	PAPZZ	PAOZZ	PAGZZ	PAZZ	D	.015	5360-00-449-5861 SPRING, ADVANCE 14259 87460		EA		1	1
71	5	XBZZ	PACZZ	PAGZZ	PAZZ			2910-00-786-6343 SHIM 12741 87460		EA		V	V
71	6	XBZZ	PACZZ	PAGZZ	PAZZ			5365-00-441-0249 SHIM 12473 87460		EA		V	V
71	7	XBZZ	PACZZ	PAGZZ	PAZZ			2910-00-980-2301 SHIM 12745 87460		EA		V	V
71	8	PAPZZ	PAOZZ	XBGZZ	PAZZ	D	.007	2910-01-005-5117 PISTON, SPRING 14733 87460		EA		1	1
71	9	PAPZZ	PACZZ	XBGZZ	PAZZ	D	.010	5310-00-787-8466 WASHER, SLIDE 12622 87460		EA		2	2
71	10	XBZZ	PACZZ	XBGZZ	XBZZ			PLUG 18968 87460		EA		1	1
71	11	PAPZZ	XB	PAGZZ	PAZZ	D	.008	2910-00-932-4787 RING, PISTON 18967 87460		EA		1	1
71	12	KFPZZ	PAOZZ	KPGZZ	KPHZZ			5330-00-061-8538 5330-00-401-5247) SEAL, RING (PART OF KIT, NSN 15750 87460		EA		1	1
71	13	PAPZZ	PAOZZ	XBGZZ	PAZZ	D	.008	2910-01-005-5118 PISTON, POWER 18243 87460		EA		1	1
71	14	XBZZ	XC	XBGZZ	XBZZ			PLUG, ADJUSTING 12765 87460		EA		1	1
71	15	KFPZZ	PAOZZ	KPGZZ	KPHZZ			5330-00-936-4587 SEAL, SCREW (PART OF KIT, NSN 5330-00-401-5247) 12766 87460		EA		1	1
71	16	PAPZZ	PAOZZ	PAGZZ	PAZZ	D	.008	2910-00-787-6428 SCREW, CAM ADJUSTING 15438 87460		EA		1	1
71	17	PAPZZ	PACZZ	PAGZZ	PAZZ	D	.008	4820-00-432-1232 SCREW ASSEMBLY 22238 87460		EA		1	1
71	18	KFPZZ	PAOZZ	KPGZZ	KPHZZ			5330-00-641-8283 RING SEAL (PART OF KIT, NSN 5330-00-401-5247) 11507 87460		EA		2	3

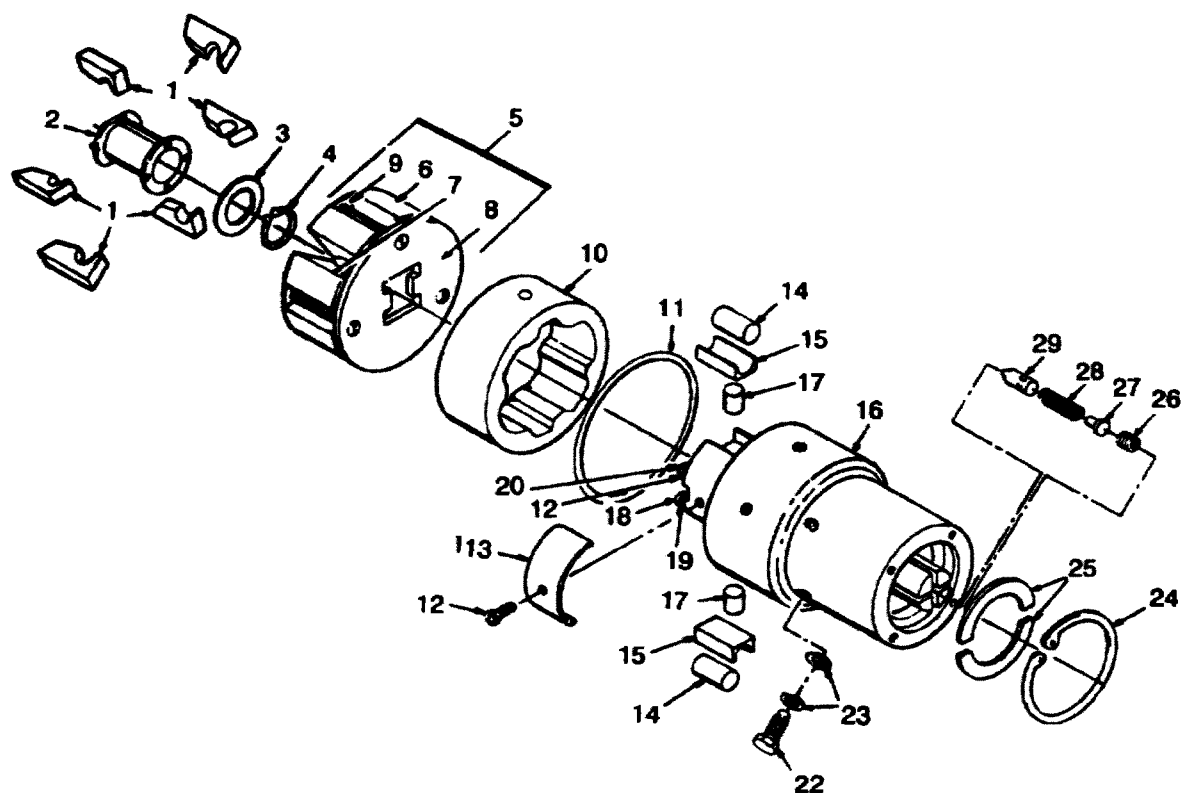


Figure 72. Fuel injection pump rotor assembly.

TM9-6115-465-24P  
 TO 35C2-3-446-4  
 NAVPAC P-8-625-24P  
 SL-4-068588/86859D

(1) ILLUSTRATION A FIG. NO.	(2) SMR CODE B ITEM NO.	(3) A ARMY	(4) B AIR FORCE	(5) C NAVY	(6) D USMC	(7) E SSI	(8) F REPL FACTOR	(9) NATIONAL STOCK NUMBER	(10) DESCRIPTION REF NUMBER & MFR CODE	(11) USABLE OR CODE	(12) QTY U/M	(13) QTY INC IN UNITS	(14) USMC QTY PER EQUIP
72	1	XBPZZ	PAOZZ	XBGZZ	PAHZZ			2910-00-289-1528	WEIGHT, GOVERNOR 20214 87460	EA	6	6	
72	2	PAPZZ	PAOZZ	XBGZZ	PAHZZ	D	.010	3120-00-886-6208	SLEEVE, THRUST 14483 87460	EA	1	1	
72	3	PAPZZ	PAOZZ	XBGZZ	PAHZZ	D	.008	5310-00-393-4067	WASHER, SLEEVE 20222 87460	EA	1	1	
72	4	PAPZZ	PAOZZ	PAGZZ	PAHZZ	D	.013	5365-00-282-7145	RING, RETAINING MS16624-93 96906	EA	1	1	
72	5	PAPZZ	PAOZZ	XBGZZ	PAHZZ		.020	2910-01-025-0457	RETAINER ASSEMBLY 20237 84760	EA	1	1	
72	6	XAPZZ	PAOZZ	XAGZZ	XAHZZ				RETAINER ASSEMBLY 20235 87460	EA	1	1	
72	7	XAPZZ	PAOZZ	XAGZZ	XAHZZ				RETAINER 20227 84760	EA	1	1	
72	8	XAPZZ	PAOZZ	XAGZZ	XAHZZ				RUD ASSEMBLY 18986 84760	EA	1	1	
72	9	XAPZZ	PAOZZ	XAGZZ	XAHZZ				RING 17513 87460	EA	1	1	
72	10	XBPZZ	PAOZZ	XBGZZ	XHHZZ				RING, CAM 18785 87460	EA	1	1	
72	11	KPZZZ	PAOZZ	KPGZZ	KPHZZ			5330-00-641-8291	SEAL, HEAD (PART OF KIT, NSN 5330-00-401-5247) 11304 87460	EA	1	1	
72	12	PAPZZ	PAOZZ	PAGZZ	PAHZZ	D	.008	5305-00-207-3984	SCREW, ADJUSTING 11175 84760	EA	1		
72	13	PAPZZ	PAOZZ	PAGZZ	PAHZZ	D	.005	5360-00-884-8209	SPRING, LEAF 11196 84760	EA	1	1	
72	14	PAPZZ	PAOZZ	PAGZZ	PAHZZ	D	.024	5315-00-887-1539	ROLLER, CAM 11141 84760	EA	2	2	
72	15	PAPZZ	PAOZZ	XBGZZ	PAHZZ	D	.008	2910-01-005-5986	SHOE, CAM ROLLER 20117 84760	EA	2	2	
72	16	XBPZZ	PAOZZ	XAGZZ	PAHZZ				HEAD ROTOR ASSEMBLY 18770 84760	EA	1	1	
72	17	XBPZZ	PAOZZ	XAGZZ	XSHZZ				PLUNGER, ROTOR 11076 84760	EA	2	2	
72	18	PAPZZ	PAOZZ	XBGZZ	PAHZZ	D	.008	2910-00-887-1547	SCREW 11438 84760	EA	2	2	
72	19	PAPZZ	PAOZZ	XDGZZ	PAHZZ	D	.013	2910-00-887-1546	WIRE, VENT 11437 84760	EA	1	1	
72	20	PAPZZ	PAOZZ	XBGZZ	PAHZZ	D	.008	2910-00-887-1564	SCREW 12216 87460	EA	1	1	
72	21	PAPZZ	PAOZZ	XBGZZ	PAHZZ		.013	2910-00-887-1548	WIRE, RETAINING 11439 84760	EA	1	1	
72	22	PAPZZ	PAOZZ	PAGZZ	PAHZZ	D	.008	4730-00-335-9315	DOLT, FLUID PASS 11346 84760	EA	6	6	

TM9-6115-465-24P  
 TO 35C2-3-446-4  
 NAVPAC P-2-625-24P  
 SL-4-068588/068590

(1) ILLUSTRATION		(2) SMR CODE		(3)		(4) NATIONAL STOCK NUMBER		(5) DESCRIPTION		(6) USABLE CN CODE	(7) QTY IN UNITS	(8) USMC QTY PER EQUIP
A FIG. NO.	B ITEM NO.	A ARMY	B AIR FORCE	C NAVY	D USMC	A SSI	B REPL FACTOR	REP NUMBER & MFR CODE		U/M		
72	23	KFPZZ	PACZZ	KPGZZ	KPHZZ			5310-00-891-8931 WASHER (PART OF KIT, NEW 5330-00-401-5247) 16225 84760		EA	12	12
72	24	PAFZZ	PACZZ	PAGZZ	PAHZZ	D	.013	5340-00-786-4027 RING, RETAINER 11208 84760		EA	1	1
72	25	PAPEZ	PACZZ	PAGEZ	PAHZZ	D	.013	5365-00-786-3964 RETAINER, ROTOR 11212 84760		EA	2	2
72	25	PAPEZ	PACZZ	PAGEZ	PAHZZ	D	.013	5365-00-786-3964 RETAINER, ROTOR 11212 84760		EA	2	2
72	26	PAPEZ	PACZZ	PAGEZ	PAHZZ	D	.008	5305-00-786-4032 SCREW, RETAINER 13837 84760		EA	1	1
72	27	PAPEZ	PACZZ	XBGZZ	PAHZZ	D	.008	2910-00-897-2461 STOP, VALVE 16440 84760		EA	1	1
72	28	PAPEZ	PACZZ	PAGEZ	PAHZZ	D	.015	5360-00-784-0330 SPRING, VALVE 13839 84760		EA	1	1
72	29	PAPEZ	PACZZ	PAGEZ	PAHZZ		.023	2910-00-786-1547 VALVE, DELIVERY 13825 84760		EA	1	1

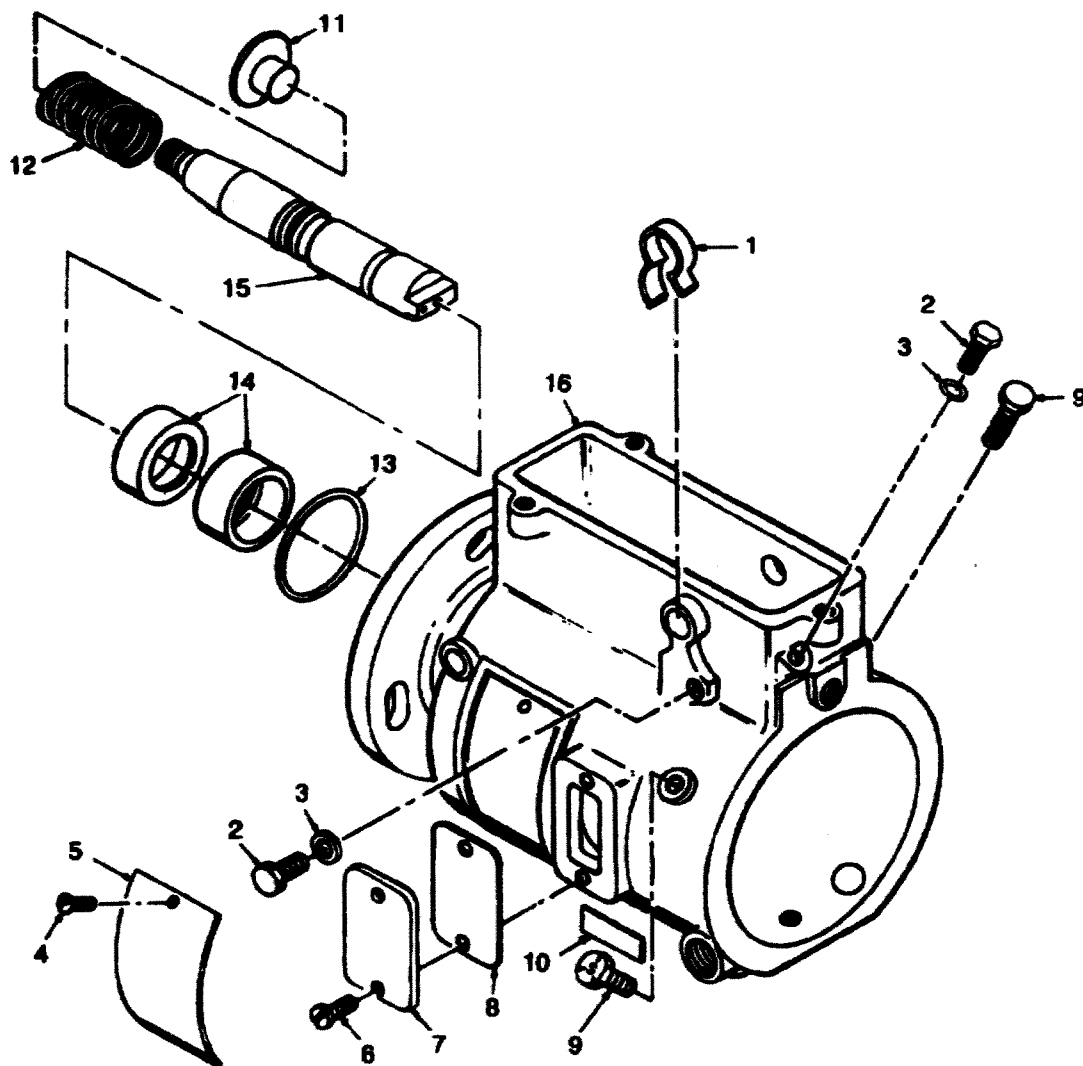


Figure 73. Fuel injection pump housing and drive shaft.



TM9-6115-465-24P  
 TO35C2-3-446-4  
 EAVPAC P-8-625-24P  
 SL-4-06858B/06859D

(1) ILLUSTRATION		(2) SMR CODE		(3)		(4) NATIONAL STOCK NUMBER		(5) DESCRIPTION		(6) USABLE ON		(7) QTY INC IN UNITS		(8) USMC QTY PER EQUIP	
A FIG. NO.	B ITEM NO.	A ARMY	B AIR FORCE	C NAVY	D USMC	A SSI	B REPL FACTOR	WFP NUMBER & WFP CODE		CODE	U/M				
73	1	PAFZZ	PACZZ	KBZZ	PAZZ	D	.008	5305-00-125-6181	STOP SCREW 16395 84760		EA	1		1	
73	2	PAFZZ	PACZZ	PAGZZ	PAZZ	D	.008	5305-00-993-8748	SCREW 12259 84760		EA	2		2	
73	3	KPFZZ	KP	KPGZZ	KPEZZ				WASHER (PART OF KIT, NSN 5330-00-401-5247) 10464 84760		EA	2		2	
73	4	PAFZZ	PACZZ	PAGZZ	PAZZ	D	.008	5305-00-253-5606	SCREW MS21318-7 96906		EA	2		2	
73	5	KPFZZ	KBOZZ	KBGZZ	KDOZZ			9905-00-473-6379	PLATE, NAME 10394 84760		EA	1		1	
73	6	PAFZZ	PACZZ	PAGZZ	PAZZ	D	.008	5305-00-156-2937	SCREW, COVER MS35190-249 96906		EA	4		4	
74	7	KPFZZ	PACZZ	KBGZZ	PAZZ			2910-00-787-6422	COVER, LITE 10567 84760		EA	2		2	
74	8	KPFZZ	PACZZ	KPHZZ	KPEZZ			5330-00-506-3975	GASKET (PART OF KIT, NSN 5330-00-401-5247) 10574 84760		EA	2		2	
73	9	PAFZZ	PACZZ	PAGZZ	PAZZ	D	.008	5306-00-819-3038	SCREW, LOCKING 11331 84760		EA	2		2	
73	10	KPFZZ	KB	KBGZZ	KDOZZ				PLATE, CAUTION 18948 84760		EA	1		1	
73	11	PAFZZ	PACZZ	PAGZZ	PAZZ	D	.008	2910-00-133-9877	BUTTON, THRUST 16144 84760		EA	1		1	
73	12	PAFZZ	PACZZ	KBGZZ	PHAZZ		.015	5360-00-887-1536	SPRING, BUTTON 10541 84760		EA	1		1	
73	13	KPFZZ	PACZZ	KPGZZ	KPEZZ			5330-00-877-4972	SHAL, TUBE (PART OF KIT, NSN 5330-00-401-5247) 10519 84760		EA	1		1	
73	14	KPFZZ	PACZZ	KPZZ	PAZZ			2910-00-757-1680	SEAL, SHAFT (PART OF KIT, NSN 5330-00-401-5247) 10453 84760		EA	2		2	
73	15	PAFZZ	PACZZ	PAGZZ	PAZZ		.020	2910-01-005-7064	SHAFT, DRIVE 20238 84760		EA	1		1	
73	16	KAFZZ	KA	XAGZZ	XAHZZ				HOUSING ASSEMBLY 17981 84760		EA	1		1	

**BOSCH VE ROTARY**

**6000LB FORKLIFT VRRT**

# TM 10-3930-660-24P

---

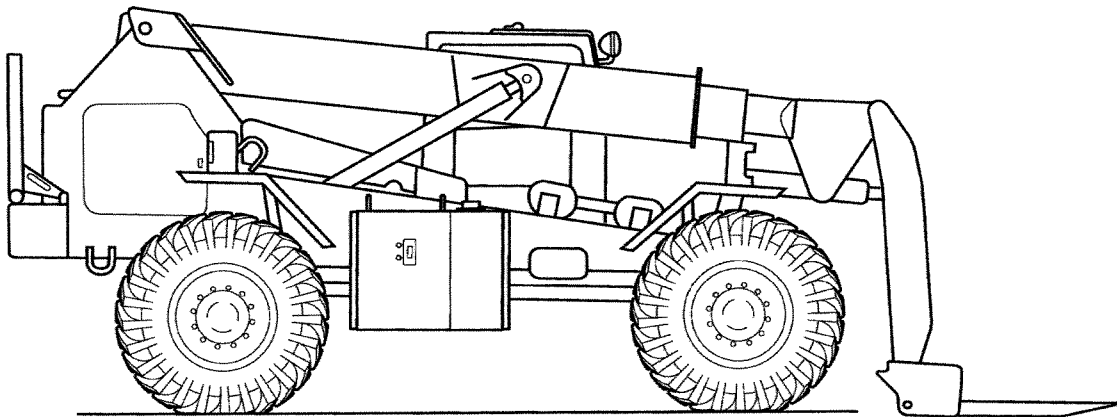
## TECHNICAL MANUAL

UNIT, DIRECT SUPPORT and GENERAL SUPPORT MAINTENANCE

REPAIR PARTS AND SPECIAL TOOLS LIST (RPSTL)  
ALSO INCLUDES DEPOT MAINTENANCE

FOR

**TRUCK, FORKLIFT; 6,000 LB.  
VARIABLE REACH, ROUGH TERRAIN  
NSN 3930-01-158-0849**



Supersedure Notice: This manual supersedes TM 10-3930-660-24P, dated 30 March 1993.

Approved for public release; distribution is unlimited.

---

**HEADQUARTERS, DEPARTMENT OF THE ARMY**

Cummins 5.9 L  
Bosch VE Pump

**MAY 2006**

1	2	41	49	101	114
2 - 129	3 - 17	42	50	102 - 104	115

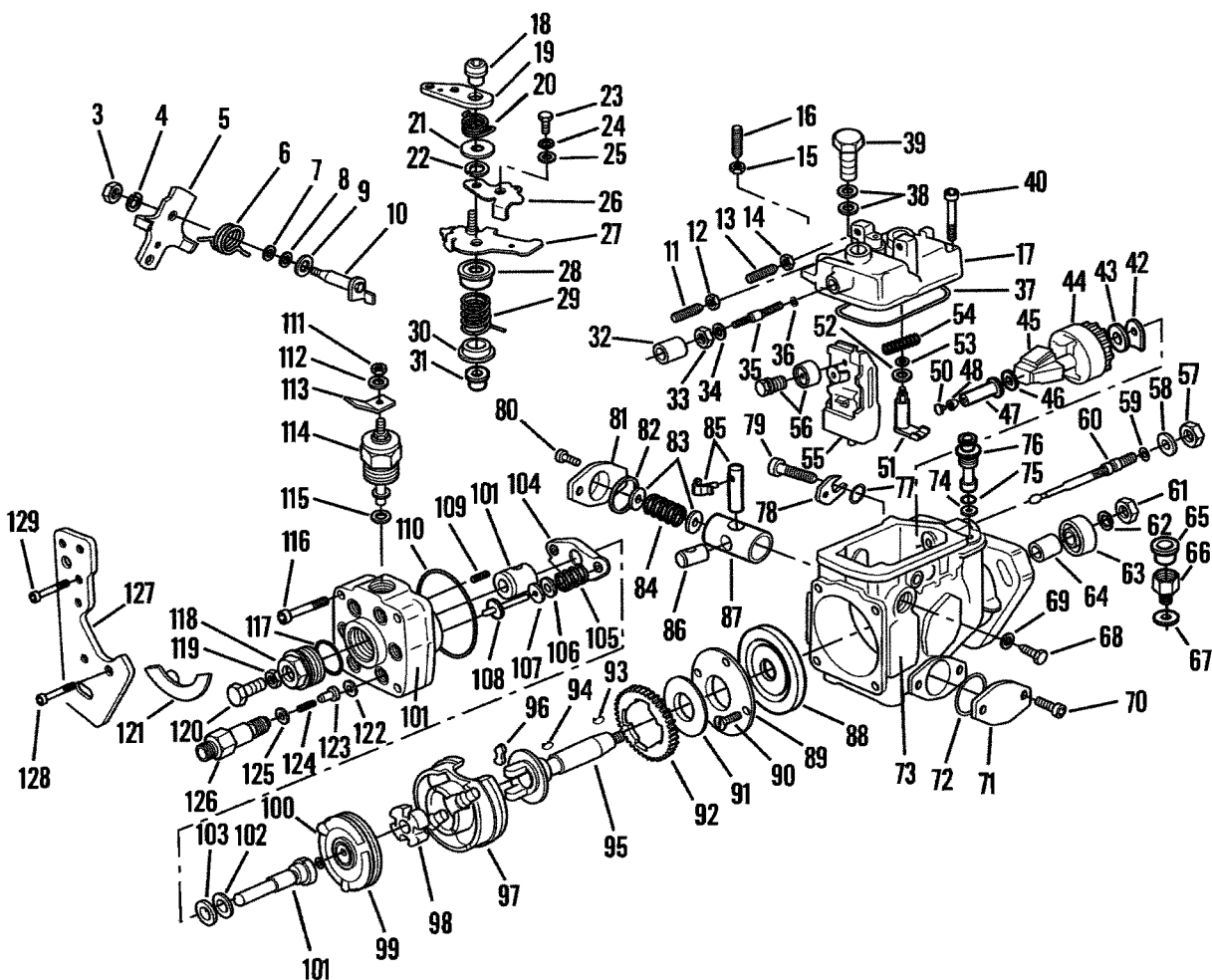


Figure 24. Fuel Injection Pump Assembly

WP 0002 00		TM10-3930-660-24P										
(1)	(2)	(3)	(4)	(5)	(6)	(7)						
ITEM	SMR			PART	DESCRIPTION AND USABLE ON CODES (UOC)					QTY		
NO	CODE	NSN	CAGEC	NUMBER								
42	PFDZZ	5365013621338	53867	1 461 030 346	..SPACER, PLATE 1.25 MM.....					1		
42	PFDZZ	5365013545745	53867	1 461 030 347	..SHIM 1.35 MM.....					1		
42	PFDZZ	5365013621339	53867	1 461 030 348	..SPACER, PLATE 1.45 MM.....					1		
42	PFDZZ	5365013621340	53867	1 461 030 349	..SPACER, PLATE 1.55 MM.....					1		
42	PFDZZ	5365013621341	53867	1 461 030 350	..SPACER, PLATE 1.65 MM.....					1		
42	PFDZZ	5365013538248	53867	1 461 030 351	..SPACER, PLATE 1.75 MM.....					1		
43	PFDZZ	5365013412978	53867	1 460 100 182	.SHIM 1.25 MM.....					1		
43	PFDZZ	5325012910038	53867	1 460 100 338	.RING, RETAINING 1.30 MM.....					1		
43	PFDZZ	5325012910039	53867	1 460 100 339	.RING, RETAINING 1.35 MM.....					1		
43	PFDZZ	5310012014654	53867	1 460 100 329	.WASHER, FLAT 1.40 MM.....					1		
43	PFDZZ	5365013756868	53867	1 460 100 183	.SHIM 1.45 MM.....					1		
44	PFDZZ	2920013059895	53867	1-466-317-319	.FLYWEIGHT, FUEL INJE.....					1		
45	PFDZZ	2990013494446	53867	1 467 010 054	.FLYWEIGHT, GOVERNOR.....					1		
46	PFDZZ	5325013068657	53867	1 460 100 356	.RING, RETAINING 1.60 MM.....					1		
47	PFDZZ	2520013405951	53867	1-460-422-324	.SLEEVE, SLIDING, MECH.....					1		
48	PFDZZ	5330013425665	53867	1 460 508 309	.SEAL, NONMETALLIC RO.....					1		
49	PFDZZ	5365013412841	53867	1 463 203 907	.PLUG, MACHINE THREAD.....					1		
50	PFDZZ	5365013412842	53867	1 463 203 413	..PLUG, MACHINE THREAD 7.60 MM.....					1		
50	PFDZZ	5365013412843	53867	1 463 203 414	..PLUG, MACHINE THREAD 7.80 MM.....					1		
50	PFDZZ	5365013412844	53867	1 463 203 415	..PLUG, MACHINE THREAD 8.00 MM.....					1		
50	PFDZZ	5365013412845	53867	1 463 203 416	..PLUG, MACHINE THREAD 8.20 MM.....					1		
50	PFDZZ	5365013418770	53867	1 463 203 417	..PLUG, MACHINE THREAD 8.40 MM.....					1		
50	PFDZZ	5365013412846	53867	1 463 203 418	..PLUG, MACHINE THREAD 8.60 MM.....					1		
50	PFDZZ	5365013412847	53867	1 463 203 419	..PLUG, MACHINE THREAD 8.80 MM.....					1		
50	PFDZZ	5365013418771	53867	1 463 203 420	..PLUG, MACHINE THREAD 9.00 MM.....					1		
50	PFDZZ	5365013408122	53867	1 463 203 421	..PLUG, MACHINE THREAD 9.20 MM.....					1		
50	PFDZZ	5365013408123	53867	1 463 203 422	..PLUG, MACHINE THREAD 9.40 MM.....					1		
50	PFDZZ	5365013408124	53867	1 463 203 423	..PLUG, MACHINE THREAD 9.60 MM.....					1		
50	PFDZZ	5365013408125	53867	1 463 203 424	..PLUG, MACHINE THREAD 9.80 MM.....					1		
50	PFDZZ	5365013408126	53867	1 463 203 425	..PLUG, MACHINE THREAD 10.00 MM.....					1		
50	PFDZZ	5365013408127	53867	1 463 203 426	..PLUG, MACHINE THREAD 10.20 MM.....					1		
50	PFDZZ	5365013408128	53867	1 463 203 427	..PLUG, MACHINE THREAD 10.40 MM.....					1		
50	PFDZZ	5365013412848	53867	1 463 203 428	..PLUG, MACHINE THREAD 10.60 MM.....					1		
50	PFDZZ	5365013412849	53867	1 463 203 429	..PLUG, MACHINE THREAD 10.80 MM.....					1		
50	PFDZZ	5365013412850	53867	1 463 203 430	..PLUG, MACHINE THREAD 11.00 MM.....					1		
51	PFDZZ	3040013405907	53867	1 463 161 849	.SHAFT, SHOULDERED.....					1		
52	PFDZZ	5310012014657	53867	1 200 101 640	.WASHER, FLAT.....					1		
53	PFDZZ	5331123155122	D8015	1 460 210 008	.O-RING PART OF KIT P/N 1 467 010					1		
54	PFDZZ	5360013756841	53867	1 464 650 388	059.....					1		
55	PFDZZ	3040013757393	53867	1 461 904 640	.SPRING, HELICAL, EXTE.....					1		
56	PFDZZ	5315013412957	53867	1 467 010 364	.LEVER, REMOTE CONTRO.....					1		
57	PFDZZ	5310013059369	53867	1 463 300 304	.PIN, SHOULDER, HEADED.....					1		
58	PFDZZ	5310011172410	53867	2 916 012 017	.NUT, PLAIN, HEXAGON.....					1		
59	PFDZZ	5331013446262	53867	1 420 210 047	.WASHER, FLAT DIN 433-10.5-ST 50....					1		
60	PFDZZ	3040013057904	53867	1 463 590 311	.O-RING PART OF KIT P/N 1 467 010					1		
61	PFDZZ	5310011857190	53867	2 915 021 004	059.....					1		
62	PFDZZ	5310013412941	53867	2 916 699 088	.SHAFT, SHOULDERED.....					1		
63	PFDZZ	5330013448014	53867	1 460 283 307	.NUT, PLAIN, HEXAGON DIN 934-M14X1.5-					1		
64	PFDZZ	3120013760580	53867	1 460 400 313	M-8.....					1		
					.WASHER, LOCK.....					1		
					.SEAL, PLAIN ENCASED.....					1		
					.BUSHING, SLEEVE.....					1		

WP 0002 00			TM10-3930-660-24P			
(1)	(2)	(3)	(4)	(5)	(6)	(7)
ITEM	SMR			PART		
NO	CODE	NSN	CAGEC	NUMBER	DESCRIPTION AND USABLE ON CODES(UOC)	QTY
105	PFDZZ	5360013756840	53867	1 467 010 053	.SPRING,HELICAL COMP.....	1
106	PFDZZ	5340012001985	53867	1 460 500 303	.SEAT,HELICAL COMPRE.....	2
107	PFDZZ	5365012006936	61724	844165-1	.SHIM.....	2
108	PFDZZ	5315013063422	53867	1 463 124 301	.PIN,STRAIGHT,HEADLE.....	2
109	PFDZZ	5360012865945	53867	1 464 613 611	.SPRING,HELICAL,COMP.....	2
110	PFDZZ	5331012867124	53867	1 900 210 154	.O-RING PART OF KIT P/N 1 467 010	1
					059.....	
111	PFDZZ	5310013058328	53867	2 915 011 006	.NUT,PLAIN,HEXAGON DIN 937-M5-M-8..	1
112	PFDZZ	5310011766494	53867	2 916 011 011	.WASHER,FLAT DIN 433-5,3-ST 50.....	1
113	PFDZZ	5940013554346	53867	1 464 477 302	.TERMINAL,LUG.....	1
114	PFFZZ	5945012902320	53867	0 330 001 016	.SOLENOID,ELECTRICAL CDC 3908214...	1
115	PFFZZ	5331012014605	53867	1 460 210 006	.O-RING PART OF KIT P/N 1 467 010	1
					059.....	
116	PFDZZ	5305013448040	53867	1 463 414 312	.SCREW,MACHINE.....	3
117	PFDZZ	5331012860801	53867	1 460 210 316	.O-RING PART OF KIT P/N 1 467 010	1
					059.....	
118	PFDZZ	5365013422531	53867	1 463 461 306	.PLUG,MACHINE THREAD.....	1
119	PFDZZ	5330123159687	53867	1 460 105 306	.GASKET.....	1
120	PFDZZ	2530013407028	53867	1 463 453 306	.VALVE,BLEEDER,HYDRA.....	1
121	PFDZZ	5340013538231	53867	1 460 591 306	.CAP,PROTECTIVE,DUST PART OF KIT P/N	1
					1 467 010 059.....	
122	PFDZZ	5330012867125	53867	1 460 105 305	.GASKET.....	6
123	PFDZZ	4820013416995	53867	1 468 532 247	.VALVE,REGULATING,FL.....	6
124	PFDZZ	5360013063434	53867	1 464 612 512	.SPRING,HELICAL,COMP.....	6
125	PFDZZ	5365012857014	53867	1 410 100 003	.SHIM.....	6
126	PFDZZ	4730013059000	53867	1-463-370-360	.NIPPLE,PIPE.....	6
127	PFDZZ	5340013413472	53867	1 461 021 354	.PLATE,MOUNTING.....	1
128	PFDZZ	5305013063472	53867	2 910 141 203	.SCREW,CAP,SOCKET HE DIN 912-M6X25-	2
					8.8.....	
129	PFDZZ	5305013448041	53867	1 463 414 305	.SCREW,MACHINE.....	1

END OF FIGURE

**DELPHI ROTARY PUMP**

**4000LB FORKLIFT RT**

**TECHNICAL MANUAL**

**UNIT,  
DIRECT SUPPORT AND  
GENERAL SUPPORT MAINTENANCE  
REPAIR PARTS AND SPECIAL TOOLS LISTS  
(INCLUDING DEPOT MAINTENANCE  
REPAIR PARTS AND SPECIAL TOOLS LISTS)**

**TRUCK, FORKLIFT, 4,000 LB. CAPACITY,  
ROUGH TERRAIN, DED, PNEUMATIC TIRE**

**ARMY MODEL MHE-270 (WITHOUT CAB)  
NSN 3930-01-330-8907**

**ARMY MODEL MHE-271 (WITH CAB)  
NSN 3930-01-330-8906**

**Approved for Public Release; Distribution is Unlimited**

---

**HEADQUARTERS, DEPARTMENT OF THE ARMY**

**November 1994**



7 — 8  
THRU  
11

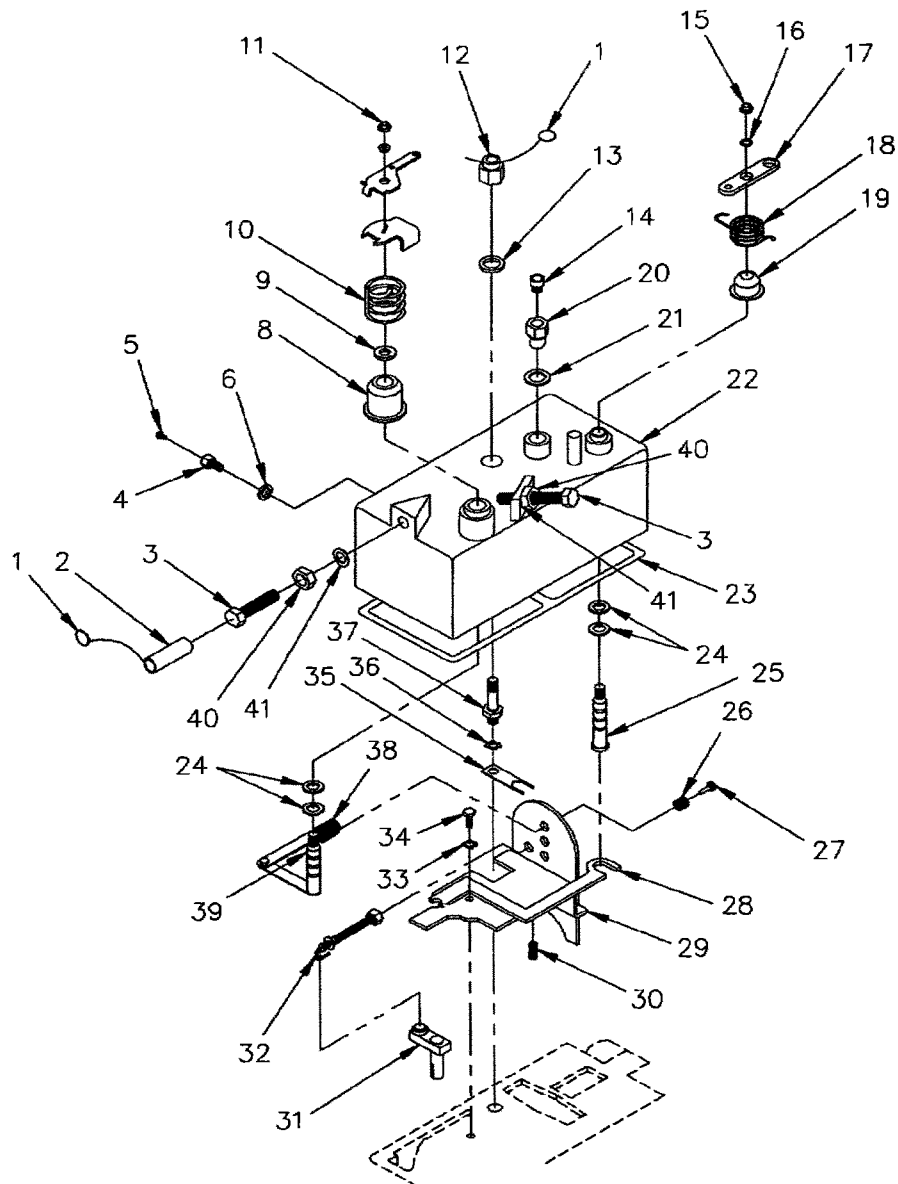


Figure 18. Fuel Injection Pump Governor Control Assembly

3.9 Governor  
Delphi Pump

SECTION II					
(1)	(2)	(3)	(4)	(5)	(6)
ITEM	SMR		PART	DESCRIPTION AND USABLE ON CODES (UOC)	QTY
NO	CODE	CAGEC	NUMBER		
GROUP 0302 FUEL PUMPS					
FIGURE 18. FUEL INJECTION PUMP					
GOVERNOR CONTROL ASSEMBLY.					
1	PFHZA	U0041	5606-62	SEAL,PUMP PART OF KIT P/N 7135-112 .....	2
2	PFHZZ	63632	7139-184	CAP,PROTECTIVE,DUST PART OF KIT P/N .....	1
				7135-112 .....	
3	PFHZZ	63632	5334-267E	SCREW,CAP,HEXAGON H .....	2
4	PFDZZ	63632	7240-20B	SCREW,CAP,HEXAGON H .....	1
5	PFHZZ	63632	7180-371	SCREW,CAP,HEXAGON H .....	1
6	KDHZZ	63632	NW5-15W4	WASHER PART OF KIT P/N 7135-112 .....	1
7	PFHZZ	63632	7135-75E	LEVERMANUAL CONTRO .....	1
8	XAHHZ	63632	7135-75A	.SEAT,HELICAL COMPREC .....	1
9	XAHHZ	63632	5936-291	.WASHER .....	1
10	XADZZ	63632	7139-442	.SPRING,HELICAL,COMP .....	1
11	PFDZZ	63632	NU9-8Y1	NUT,PLAIN,HEXAGON .....	1
12	PFHZZ	63632	5330-344	NUT,PLAIN,CAP .....	2
13	PFHZZ	03798	5339-970	WASHER PART OF KIT P/N 7135-112 .....	2
14	PFHZZ	63632	9120-041A	PLUG,PROTECTIVE,DUS .....	1
15	PFDZZ	63632	5330-406	NUT,SELF-LOCKING,HE PART OF KIT P/N .....	1
				7135-112 .....	
16	PFHZZ	63632	NP1-5	WASHER,LOCK PART OF KIT P/N 7135-112 .....	1
17	PFHZZ	63632	7123-725B	LEVER,GOVERNOR .....	1
18	PFHZZ	63632	7139-991	SPRING SPECIAL .....	1
19	PFHZZ	63632	7139-937	SEAT,HELICAL COMPRE .....	1
20	PFHZZ	63632	9120-005	AOAPTER,STRAIGHT,TU .....	1
21	PFHZZ	63632	5936-332C	WASHER,FLAT PART OF KIT P/N 7135-112 .....	1
22	PFHZZ	63632	7123-888N	COVER,HYDRAULIC,PUM .....	1
23	PFHZZ	63632	7123-287	GASKET PART OF KIT P/N 7135-112 .....	1
24	PFHZZ	63632	5855-30	SEAL PART OF KIT P/N 7135-112 .....	4
25	PFHZZ	63632	7123-726	SHAFT,SHOULDERED .....	1
26	PFHZZ	63632	7123-920	SPRING,HELICAL,COMP .....	1
27	PFHZZ	63632	7123-93	HOLDERSPRING .....	1
28	PFHZZ	63632	7123-304B	BARSHUT OFF,GOVERN .....	1
29	PFHZZ	63632	7135-76X	ARM,GOVERNOR,FUEL .....	1
30	PFHZZ	63632	7123-89	SPRING,HELICAL,COMP .....	1
31	PFHZZ	63632	7139-559P	VALVE,FUEL SYSTEM .....	1
32	PFHZZ	63632	7123-453B	LINK,SPRING,GOVERNO .....	1
33	PFHZZ	63632	7167-331	WASHER SPECIAL PART OF KIT P/N 7135- .....	1
				112 .....	
34	PFHZZ	63632	5334-277	SCREW .....	1
35	PFHZZ	63632	7123-355	PLATE,KEEP,GOVERNOR .....	1
36	PFHZZ	63632	7123-600	WASHER#LOCK .....	2
37	PFHZZ	63632	7123-527	STUD,SHOULDERED .....	2
38	PFHZZ	63632	7123-898S	SPRING,HELICAL#COMP .....	1
39	PFHZZ	63632	7123-770A	SHAFT,SHOULDERED .....	1
40	PFHZZ	63632	NU9-8Y1	NUT,PLAIN,HEXAGON .....	2
41	PFHZZ	63632	NW1-65Y1	WASHER,FLAT .....	2

END OF FIGURE

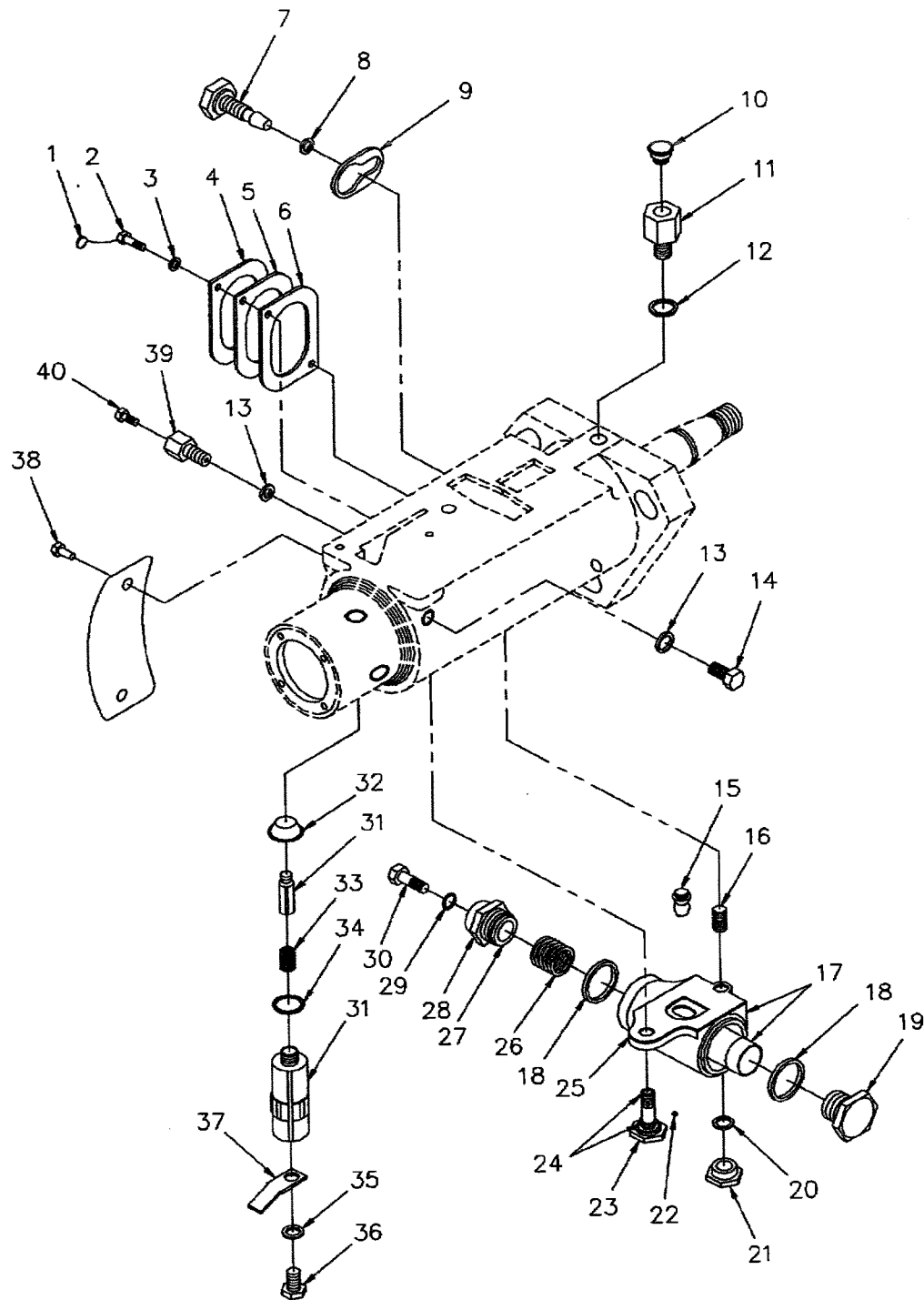


Figure 19. Fuel Injection Pump Hydraulic Head and Housing Attachment

SECTION II				(5)	(6)
(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	DESCRIPTION AND USABLE ON CODES (UOC)	QTY
GROUP 0302 FUEL PUMPS FIGURE 19. FUEL INJECTION PUMP HYDRAULIC HEAD AND HOUSING ATTACHMENTS.					
1	PAHZZ	63632	7135-112	PARTS KIT,METERING PART OF KIT P/N ..... 7135-112 .....	1
2	PFHZZ	63632	5334-274	SCREW .....	2
3	PFHZZ	63632	NPI-5	WASHER,LOCK PART OF KIT P/N 7135-112 .....	2
4	XDHZZ	63632	9120-028	PLATE,IDENTIFICATIO .....	1
5	PFHZZ	63632	7180-55A	COVER,ACCESS5.....	1
6	PFHZZ	63632	9045-137	GASKET PART OF KIT P/N 7135-112 .....	1
7	PFHZZ	63632	9120-009	SCREW,MACHINE .....	1
8	PFHZZ	63632	5855-30BR	SEAL RING,METAL .....	1
9	PFHZZ	63632	9120-004	WASHER,FLAT .....	1
10	KDHZZ	63632	9120-041B	PLUG,PROTECTION PART OF KIT P/N ..... 7135-112 .....	1
11	PFHZZ	63632	9120-OIOA	VALVE,CHECK .....	1
12	PFHZZ	63632	5936-332C	WASHER,FLAT PART OF KIT P/N 7135-112 .....	1
13	PFHZZ	63632	NW5-18W4	WASHER PART OF KIT P/N 7135-112 .....	2
14	PFHZZ	63632	5334-280	SCREW,CAP,HEXAGON H.....	1
15	PFHZZ	63632	7123-975	SCREW .....	1
16	PFHZZ	63632	5335-694A	STUD,PLAIN .....	1
17	PFHZZ	63632	7123-8198N	HOUSING,FUEL CONTRO.....	1
18	PFHZZ	63632	5855-30B0	PACKINGVPREFORMED PART OF KIT P/N ..... 7135-112 .....	2
19	PFHZZ	63632	7123-473	PLUG,PIPE .....	1
20	PFHZZ	63632	7022-18OD	WASHER,FLAT PART OF KIT P/N 7135-112 .....	1
21	PFHZZ	63632	5330-362	NUT,PLAIN,CAP .....	1
22	KDHZZ	63632	NC7-8	BALL PART OF KIT P/N 7135-112 .....	1
23	PFHZZ	63632	7123-261B	BOLT,MACHINE .....	1
24	PFHZZ	63632	7139-821	SEAL RING,METAL PART OF KIT P/N 7135..... 112 .....	2
25	PAHZZ	63632	7123-937	GASKET PART OF KIT P/N 7135-112 .....	1
26	PFHZZ	63632	7123-294R	SPRING, HELICAL,COMP .....	1
27	PFHZZ	63632	NW2-279	SHIM .....	1
28	PFHZZ	63632	7167-305	SCREW,MACHINE .....	1
29	PFHZZ	63632	5936-355C	WASHER,FLAT PART OF KIT P/N 7135-..... 112 .....	1
30	PFHZZ	63632	7167-299	.SCREW,CAP,HEXAGON H.....	1
31	PAFZZ	63632	7180-49A	SOLENOID,ELECTRICAL .....	1
32	XAFZZ	63632	7098-1098	.CAP, PROTECTIVE.....	1
33	XAFZZ	63632	7167-787	.SPRING,HELICAL,COMP.....	1
34	PAFZZ	63632	5855-30DT	.PACKING,PREFORMED PART OF KIT P/N..... 7135-112 .....	1
35	XAFZZ	63632	7167-786	.WASHER,FLAT .....	1
36	XAFZZ	63632	7167-785	.SCREW,CAP,SOCKET HE.....	1
37	XAFZZ	63632	9120-055	.LUCAR BLADE .....	1
38	XAHZZ	63632	NR21-4	RIVET,BLIND .....	2
39	PFHZZ	63632	7123-3528	RESTRICTOR,FLUID .....	1
40	PFHZZ	63632	7180-371	.SCREW,CAP,HEXAGON H.....	1

END OF FIGURE

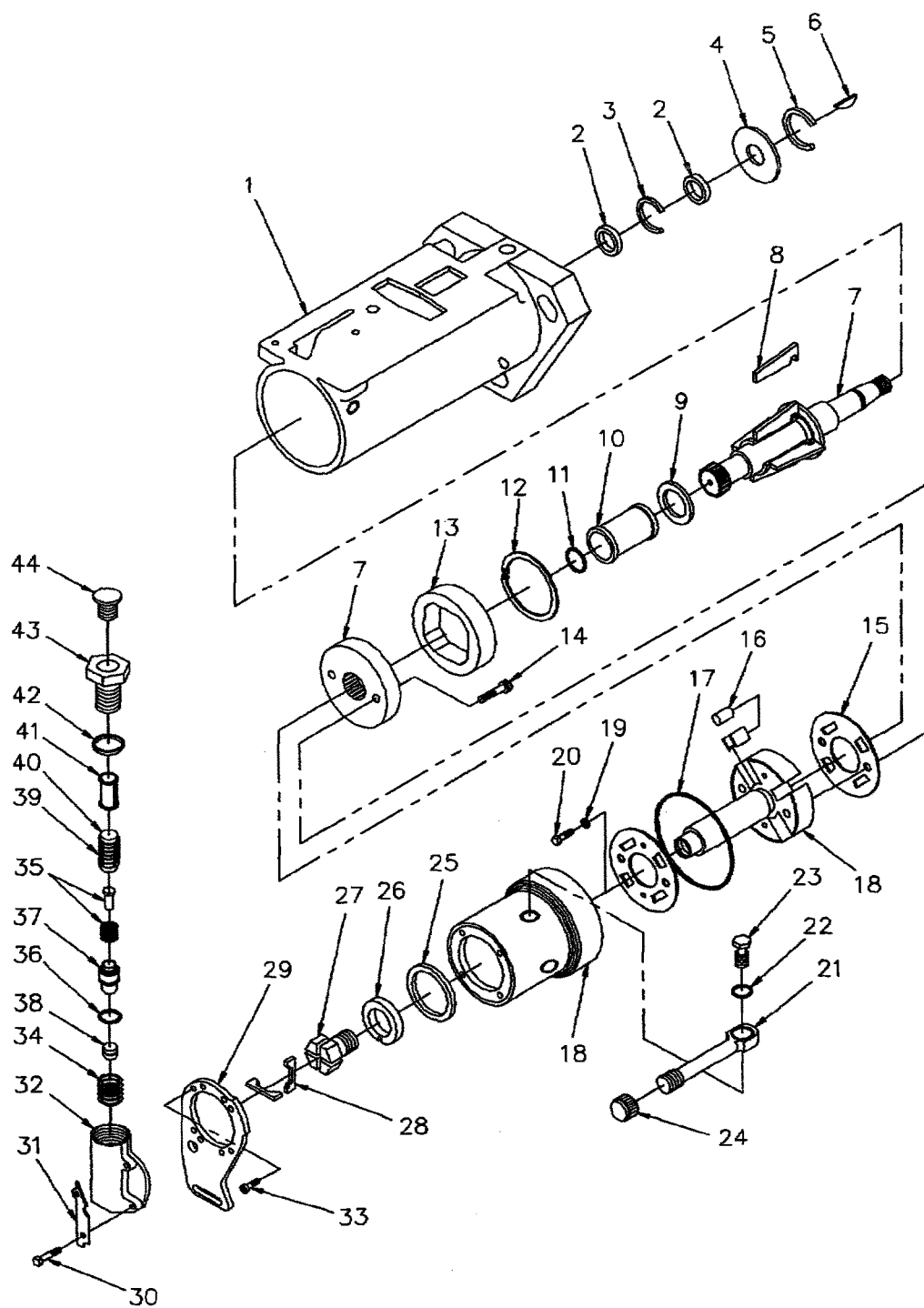


Figure 20. Fuel Injection Pump Body Assembly

SECTION II				(5)	(6)
(1)	(2)	(3)	(4)		
ITEM NO	SMR CODE	CAGEC	PART NUMBER	DESCRIPTION AND USABLE ON CODES (UOC)	QTY
				GROUP 0302 FUEL PUMPS	
				FIGURE 20. FUEL INJECTION PUMP	
				BODY ASSEMBLY.	
1XAHZZ	63632	7123-454CF		HOUSING, LIQUID PUMP .....	1
2	PFHZZ	63632	5393-252R	.SEAL, PLAIN ENCASED .....	2
3	PFHZZ	63632	5950-137	.RING, RETAINING. 000.1011 .....	1
4	PFFZZ	63632	7139-955	BEARING, WASHER, THRU .....	1
4	PFFZZ	63632	7139-955A	BEARING, WASHER, THRU .....	1
4	PFFZZ	63632	7139-9558	BEARING, WASHER, THRU .....	1
4	PFFZZ	63632	7139-955C	BEARING, WASHER, THRU .....	1
4	PFFZZ	63632	7139-955D	BEARING, WASHER, THRU .....	1
5	PFFZZ	63632	NM1-9	RING, RETAINING .....	1
6	PFFZZ	63632	NKI-22	KEY, WOODRUFF PART OF KIT P/N 7135-112 .....	1
7	XAHZZ	63632	7180-136B	SHAFT, DRIVE .....	1
8	PFHZZ	63632	7123-914G	WEIGHT, ENGINE GOVER .....	4
9	PFHZZ	63632	5936-124	BEARING, WASHER, THRU .....	1
10	PFHZZ	63632	7123-818	BEARING, WASHER, THRU .....	1
11	PFHZZ	63632	5921-16	RING, RETAINING .....	1
12	PFHZZ	63632	5950-64A	RING .....	1
13	XAHZZ	63632	7167-976D CAM	RING .....	1
14	PFHZZ	63632	5334-245	SCREW, DRIVE .....	1
15	PFHZZ	63632	7135-73A	SPACER, PLATE .....	1
16	PFHZZ	63632	7135-72	ROLLER SHOE KIT .....	1
17	PFHZZ	63632	5855-308C	PACKING, PREFORMED PART OF KIT P/N 7135-112 .....	1
18	XAHZZ	63632	7180-93U	HEAD, HYD & ROTOR .....	1
19	PFHZZ	63632	5339-964	WASHER, FLAT PART OF KIT P/N 7135-112 .....	1
20	PFHZZ	63632	5335-684	SCREW .....	1
21	PFHZZ	63632	7139-354	BOLT, FLUID PASSAGE .....	4
22	PAHZZ	63632	7135-112	PARTS KIT, METERING PART OF KIT P/N 7135-112 .....	4
23	PFHZZ	63632	9120-019	VALVE, REGULATING, FL .....	4
24	KDHZZ	63632	9120-0418	PLUG, PROTECTION PART OF KIT P/N 7135-112 .....	4
25	PFHZZ	63632	7139-43	GASKET PART OF KIT P/N 7135-112 .....	1
26	PFHZZ	63632	7139-540	LINER, TRANSFER PUMP .....	1
27	PFHZZ	63632	7123-18D	IMPELLER, PUMP, CENTR .....	1
28	PFHZZ	63632	7123-19	IMPELLER, PUMPCENTRR .....	2
29	PFHZZ	63632	9120-020A	BRACKET, MOUNTING .....	1
30	PFHZZ	63632	5334-315F	SCREW, CAP, HEXAGON H .....	4
31	PFHZZ	63632	7139-267	CLAMP, RIM CLENCHING .....	2
32	XAHZZ	63632	7123-576P	VALVE HEAD, HYDRAULI .....	1
33	PFHZZ	63632	7167-667	SCREW, CAP, SOCKET H .....	4
34	PFHZZ	63632	7123-439	SPRING .....	1
35	PFHZZ	63632	7167-183A	GUIDE, FUEL PUMP .....	1
36	PFHZZ	63632	5936-177	WASHER, FLAT PART OF KIT P/N 7135-112 .....	1
37	PFHZZ	63632	7135-74L	SLEEVE, DI RECTIONAL .....	1
38	PFDZZ	63632	7123-15G	.PISTON, PUMP .....	1
39	PFHZZ	U0041	7123-551	SPRING, HELICAL, COMP .....	1
40	PFHZZ	63632	7139-650G	ADJUSTOR, FUEL COMPO .....	1

SECTION II				(5)	(6)
(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	DESCRIPTION AND USABLE ON CODES (UOC)	QTY
41	PFHZZ	63632	7123-620	FILTER ELEMENT.FLUI PART OF KIT P/N ..... 7135-112 .....	1
42	KDHZZ	63632	NW5-77W4	WASHER PART OF KIT P/N 7135-112 .....	1
43	PFHZZ	63632	9120-007	ITEOSPECIAL.....	1
44	KDHZZ	63632	9120-041B	PLUG,PROTECTION PART OF KIT P/N ..... 7135-112 .....	1
				END OF FIGURE	
				20-2	





SECTION II					
(1)	(2)	(3)	(4)	(5)	(6)
ITEM	SMR		PART	DESCRIPTION AND USABLE ON CODES (UOC)	QTY
NO	CODE	FSCM	NUMBER		
<b>GROUP 0302 FUEL PUMPS</b>					
<b>FIGURE 21. FUEL INJECTION PUMP LINES</b>					
1	PFOZZ	15434	3905307	BOLT,FLUID PASSAGE M6X1.00X14MM .....	4
2	PFOZZ	15434	3903380	SEAL,BANJO CONNECT PART OF KIT P/N.....	4
				3802361 PART OF KIT P/N 3802217 PART	
				OF KIT PJN 3802218.....	
3	PFOZZ	15434	3909695	TUBE ASSEMBLY,METAL .....	1
4	PAOZZ	15434	3903522	TUBE ASSEMBLY,METAL .....	1
5	PAOZZ	15434	3903523	TUBE ASSEMBLY,METAL .....	1
6	PFOZZ	15434	3914338	FAIRLEAD,BLOCK .....	8
7	PFOZZ	15434	3910588	BRACKET,ANGLE .....	1
8	PAOZZ	15434	3903525	TUBE ASSEMBLY,METAL .....	1
9	PAOZZ	15434	3903524	TUBE ASSEMBLY,METAL .....	1
10	PFOZZ	15434	3904711	BRACKET,DOUBLE ANGL .....	4
11	PFOZZ	15434	3903609	SCREW,CAP,HEXAGON H M5X0.80X20MM .....	4
12	PFOZZ	15434	3903723	WASHER .....	4
13	PFOZZ	15434	3910589	BRACKET,ANGLE .....	1
14	PFOZZ	15434	3918109	.SCREW,CAP,HEXAGON H .....	2
15	PFOZZ	15434	3904344	BRACKET,ANGLE .....	1
16	PFOZZ	15434	3904345	BRACKET,ANGLE .....	1
17	PFOZZ	15434	3905388	TEE, TUBE .....	1
18	PAOZZ	15434	3905391	.GROMMET,NONMETALLIC .....	3
19	PFOZZ	15434	3912137	TUBE ASSEMBLY,METAL .....	1
20	PFOZZ	15434	3900630	SCREWCAP,HEXAGON H M8X1.25X20MM .....	2
21	PAOZZ	15434	3900267	GROMMET PART OF KIT P/N 3802019. ....	2
22	PFOZZ	81343	3-2 060103BA	ADAPTER,STRAIGHT,PI .....	1
23	PFOZZ	15434	3903037	WASHERP .....	2
24	PFOZZ	5A910	12MM-4FB-BANJO	BDLT,FLUID PASSAGE .....	1
25	PFOZZ	96906	MS28778-4	PACKING,PREFORMED .....	1
26	PFOZZ	O51H5	6505-4-4	FITTING,STRAIGHT .....	1
29	PFOZZ	83179	236559	ADAPTER,STRAIGHT PI .....	1
30	AOOZZ	15434	3905432	TUBE ASSEMBLY,METAL .....	1
31	PFOZZ	15434	3905364	TUBE ASSEMBLY,METAL .....	1
32	PFOZZ	15434	3905375	TUBE ASSEMBLY,METAL .....	1
33	PAOZZ	15434	3905351	.GROMMET,NONMETALLIC .....	2
34	PFOZZ	15434	3905363	TUBE ASSEMBLY,METAL .....	1
35	PFOZZ	15434	3905353	TEE,PIPE .....	1
36	PFOZZ	15434	3905703	TUBE ASSEMBLY,METAL .....	1

END OF FIGURE

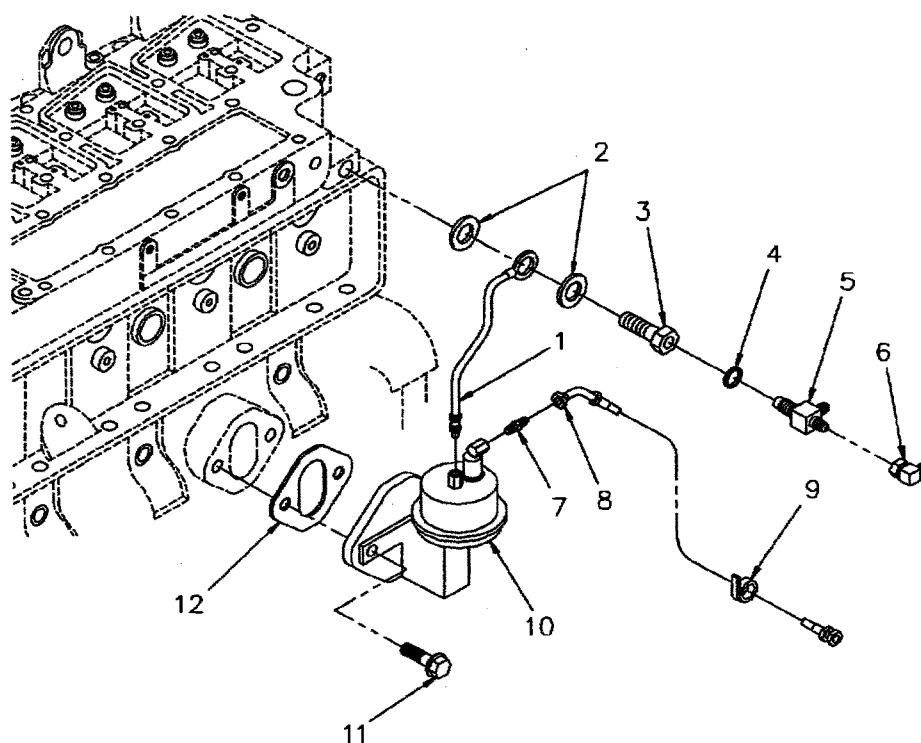


Figure 22. Fuel Transfer Pump and Lines

SECTION II					
(1)	(2)	(3)	(4)	(5)	(6)
ITEM	SMR		PART		
NO	CODE	FSCM	NUMBER	DESCRIPTION AND USABLE ON CODES (UOC)	QTY

## GROUP 0302 FUEL PUMPS

FIGURE 22 FUEL TRANSFER PUMP AND  
LINES

1	PFOZZ	15434	3905649	TUBE ASSEMBLY,METAL .....	1
2	PFOZZ	15434	3903037	WASHER .....	2
3	PFOZZ	5A910	12MM-4FB-BANJO	BOLT,FLUID PASSAGE M12XI.5OX24MM.....	1
4	PFOZZ	96906	MS28778-4	PACKING,PREFORMED .....	1
6	PFOZZ	06581	AA67028-4K	ELBOW,TUBE, .....	1
7	PFOZZ	81343	6-4 070102	ADAPTER,STRAIGHT .....	1
8	PAOZZ	01276	1C02033GGG0564	HOSE ASSEMBLY NONME .....	1
9	PFOZZ	96906	MS21333-128	CLAMP,LOOP .....	1
10	PFOZZ	15434	3904374	PUMP,FUEL,CAM ACTUA .....	1
11	PFOZZ	15434	3900631	SCREW,CAP,HEXAGON H M8X1.25X25MM1.....	2
12	PAOZZ	15434	3914304	GASKET PART OF KIT P/N 3802019 .....	1

END OF FIGURE

22-1

# **CUMMINS PRESSURE TIMED INJECTION PUMP**

**M939/A1 SERIES 5 TON TRUCK**

**M2/3 BRADLEY**



SECTION II							
(1)	(2)	(3)	(4)	(5)	(6)	(7)	
ITEM NO	SMR CODE	NSN	CAGEC	PART NUMBER	DESCRIPTION AND USABLE ON CODES (UOC)	QTY	
GROUP 0302 FUEL PUMPS							
FIG. 51 FUEL PUMP HOUSING AFC(M939, M939A1)							
1	PAHZZ	5365011601832	15434	112076	PLUG, FUEL OUTLET .....	1	
					UOC:DAA, DAB, DAC, DAD, DAE, DAF, DAG, DAH, DAJ, DAK, DAW, DAX, V12, V13, V14, V15, V16, V17, V19, V20, V21, V22, V24, V25, V39		
2	PBH HH	2910013031195	15434	3043254	HOUSING, FUEL PUMP .....	1	
					UOC:DAA, DAB, DAC, DAD, DAE, DAF, DAG, DAH, DAJ, DAK, DAW, DAX, V12, V13, V14, V15, V16, V17, V19, V20, V21, V22, V24, V25, V39		
3	PBHZZ	2910010803149	15434	AR41010	.SHAFT ASSEMBLY, THRO .....	1	
					UOC:DAA, DAB, DAC, DAD, DAE, DAF, DAG, DAH, DAJ, DAK, DAW, DAX, V12, V13, V14, V15, V16, V17, V19, V20, V21, V22, V24, V25, V39		
4	PAHZZ	5330000819289	15434	100478	..O-RING PART OF KIT P/N 3010240 .....	1	
					UOC:DAA, DAB, DAC, DAD, DAE, DAF, DAG, DAH, DAJ, DAK, DAW, DAX, V12, V13, V14, V15, V16, V17, V19, V20, V21, V22, V24, V25, V39		
5	PAHZZ	5330010728983	15434	213768	..O-RING .....	1	
					UOC:DAA, DAB, DAC, DAD, DAE, DAF, DAG, DAH, DAJ, DAK, DAW, DAX, V12, V13, V14, V15, V16, V17, V19, V20, V21, V22, V24, V25, V39		
6	PAHZZ	5305010728826	15434	3076040	..SCREW .....	1	
					UOC:DAA, DAB, DAC, DAD, DAE, DAF, DAG, DAH, DAJ, DAK, DAW, DAX, V12, V13, V14, V15, V16, V17, V19, V20, V21, V22, V24, V25, V39		
7	PBHZZ	2910011224015	15434	3006430	..THROTTLE ASSEMBLY .....	1	
					UOC:DAA, DAB, DAC, DAD, DAE, DAF, DAG, DAH, DAJ, DAK, DAW, DAX, V12, V13, V14, V15, V16, V17, V19, V20, V21, V22, V24, V25, V39		
8	PFHZZ	3040011504926	15434	3006350	...SHAFT, THROTTLE .....	1	
					UOC:DAA, DAB, DAC, DAD, DAE, DAF, DAG, DAH, DAJ, DAK, DAW, DAX, V12, V13, V14, V15, V16, V17, V19, V20, V21, V22, V24, V25, V39		
9	PAHZZ	5305011355446	15434	3006344	...SETSCREW .....	1	
					UOC:DAA, DAB, DAC, DAD, DAE, DAF, DAG, DAH, DAJ, DAK, DAW, DAX, V12, V13, V1, VV15, V16, V17, V19, V20, V21, V22, V24, V25, V39		
10	PBHZZ	3040010861449	15434	3006343	...COLLAR, SHAFT THROTTLE SHAFT STOP .....	1	
					UOC:DAA, DAB, DAC, DAD, DAE, DAF, DAG, DAH, DAJ, DAK, DAW, DAX, V12, V13, V14, V15, V16, V17, V19, V20, V21, V22, V24, V25, V39		
11	PAHZZ	5330009703461	15434	68061-A	O-RING PART OF KIT P/N 3011472 .....	1	
					UOC:DAA, DAB, DAC, DAD, DAE, DAF, DAG, DAH, DAJ, DAK, DAW, DAX, V12, V13, V14, V15, V16, V17, V19, V20, V21, V22, V24, V25, V39		
12	PAHZZ	4730010784703	15434	3004293	PLUG, TUBE FITTING, T .....	1	
					UOC:DAA, DAB, DAC, DAD, DAE, DAF, DAG, DAH, DAJ, DAK, DAW, DAX, V12, V13, V14, V15, V16,		

SECTION II						
(1)	(2)	(3)	(4)	(5)	(6)	(7)
ITEM NO	SMR CODE	NSN	CAGEC	PART NUMBER	DESCRIPTION AND USABLE ON CODES (UOC)	QTY
13	PAHZZ	5340007164975	15434	110058	V17, V19, V20, V21, V22, V24, V25, V39 POST, ELECTRICAL-MEC ..... UOC:DAA, DAB, DAC, DAD, DAE, DAF, DAG, DAH, DAJ, DAK, DAW, DAX, V12, V13, V14, V15, V16, V17, V19, V20, V21, V22, V24, V25, V39	1
14	PAHZZ	5310009717989	96906	MS35691-5	NUT, PLAIN, HEXAGON ..... UOC:DAA, DAB, DAC, DAD, DAE, DAF, DAG, DAH, DAJ, DAK, DAW, DAX, V12, V13, V14, V15, V16, V17, V19, V20, V21, V22, V24, V25, V39	2
15	PAHZZ	5305011099307	15434	195755	SCREW ..... UOC:DAA, DAB, DAC, DAD, DAE, DAF, DAG, DAH, DAJ, DAK, DAW, DAX, V12, V13, V14, V15, V16, V17, V19, V20, V21, V22, V24, V25, V39	1
16	PAHZZ	5325002562846	96906	MS16632-1050	RING, RETAINING ..... UOC:DAA, DAB, DAC, DAD, DAE, DAF, DAG, DAH, DAJ, DAK, DAW, DAX, V12, V13, V14, V15, V16, V17, V19, V20, V21, V22, V24, V25, V39	1
17	PAHZZ	3110010798190	15434	213769	BALL, BEARING PART OF KIT P/N 5704519 ..... UOC:DAA, DAB, DAC, DAD, DAE, DAF, DAG, DAH, DAJ, DAK, DAW, DAX, V12, V13, V14, V15, V16, V17, V19, V20, V21, V22, V24, V25, V39	1
18	PAHZZ	4320010985115	15434	3000446	COVER, HYDRAULIC, PUM ..... UOC:DAA, DAB, DAC, DAD, DAE, DAF, DAG, DAH, DAJ, DAK, DAW, DAX, V12, V13, V14, V15, V16, V17, V19, V20, V21, V22, V24, V25, V39	1
19	PAHZZ	5305008046318	15434	S-2286	SCREW PART OF KIT P/N 5704519 ..... UOC:DAA, DAB, DAC, DAD, DAE, DAF, DAG, DAH, DAJ, DAK, DAW, DAX, V12, V13, V14, V15, V16, V17, V19, V20, V21, V22, V24, V25, V39	2
20	PAHZZ	4730011243762	15434	3025460	PLUG, PIPE ..... UOC:DAA, DAB, DAC, DAD, DAE, DAF, DAG, DAH, DAJ, DAK, DAW, DAX, V12, V13, V14, V15, V16, V17, V19, V20, V21, V22, V24, V25, V39	3
21	PAHZZ	5305000635043	88044	AN565F428H24	SETSCREW ..... UOC:DAA, DAB, DAC, DAD, DAE, DAF, DAG, DAH, DAJ, DAK, DAW, DAX, V12, V13, V14, V15, V16, V17, V19, V20, V21, V22, V24, V25, V39	1

END OF FIGURE